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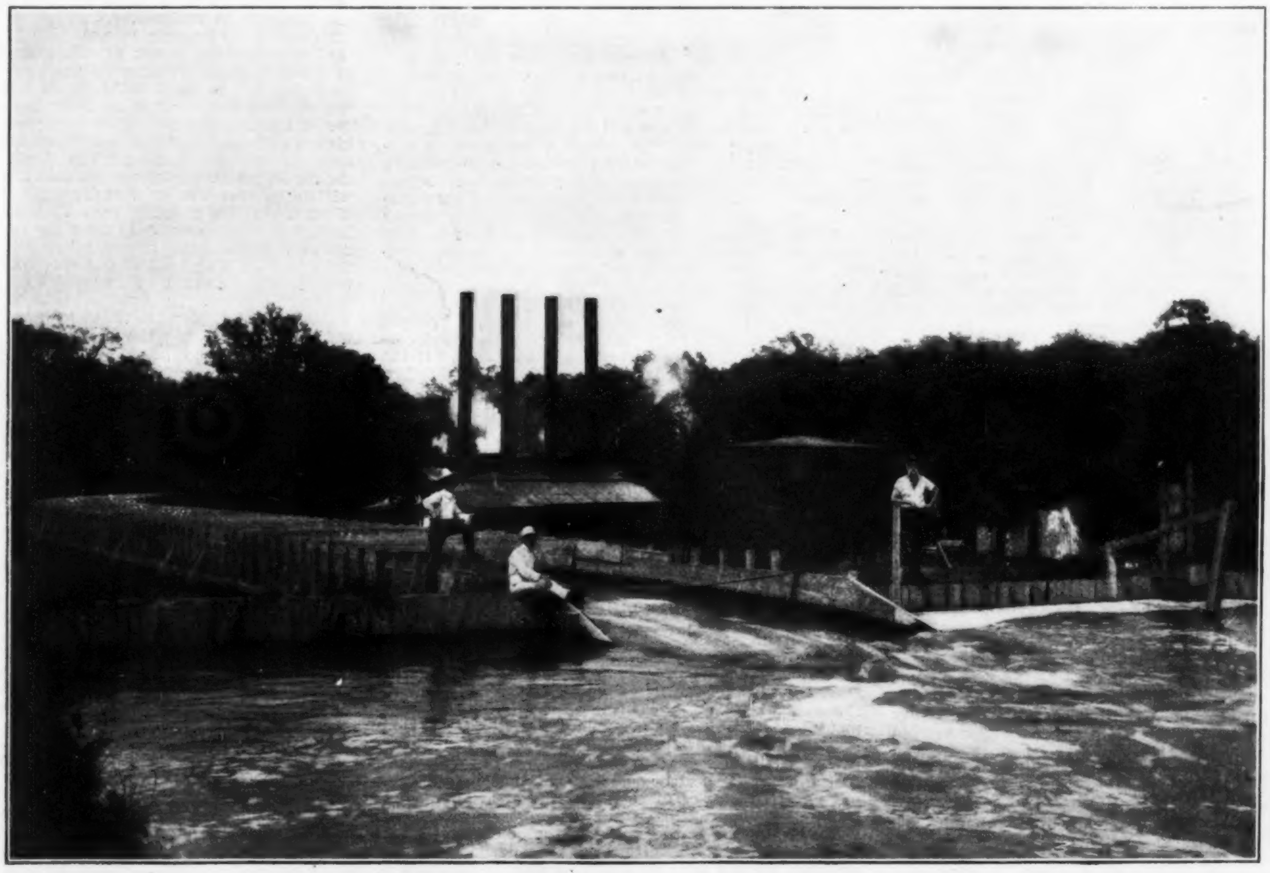
PUMPING STATION IN VERMILION PARISH, LOUISIANA, WHICH SUPPLIES WATER FOR 30,000 ACRES OF RICE.



FLOODING A RICE FIELD.

RICE CULTURE IN THE UNITED STATES.

RICE CULTURE IN THE UNITED STATES.

By DR. S. A. KNAPP.

RICE forms the principal food of one-half the population of the earth. It is more widely and generally used as a food material than any other cereal. Where dense populations are dependent for food upon an annual crop, and the climate permits its cultivation, rice has been selected as the staple food. The luxuriant growth of leguminous plants (beans, peas, etc.) at all seasons in tropical climates provides the nitrogenous food elements necessary to supplement rice. A combination of rice and legumes is a much cheaper complete food ration than wheat and meat and can be produced on a much smaller area.

Rice is an annual plant belonging to the natural family of the grasses. There is an immense number of varieties of cultivated rice, differing in length of the season required for maturing, and in character, yield, and quality. Their divergence not only extends to size, shape, and color of the grain, but to the relative proportion of food constituents and the consequent flavor. South Carolina and Japan rices are rich in fats, and hence are ranked high in flavor and nutrition among rice-eating nations. A botanical catalogue enumerates 161 varieties found in Ceylon alone, while in Japan, China, and India, where its cultivation has gone on for centuries, and where great care is usually taken in the improvement of the crop by the selection of the seed, no less than 1,400 varieties are said to exist.

The two principal varieties of lowland rice cultivated in the Atlantic States are the "gold seed," so called from the golden-yellow color of its husk when ripe, and the "white rice," the original rice introduced into this country in 1694, which has a cream-colored husk and resembles the rice commonly grown in China.

The gold-seed rice, justly famous for the quality and large yield of the grain, stands, in the estimation of the market, among the first rices in the world. Along the Atlantic coast it has practically superseded the white rice which was generally cultivated in the earlier periods of the industry. The two varieties of gold-seed appear to differ little except that one has a slightly larger grain than the other. White rice is valued for its early maturity.

The principal variety hitherto planted in Louisiana is the Honduras, so named from the country which furnishes the seed. The grain is similar in general appearance and character to that of the Carolina rice, but the kernel is slightly larger and the straw stiffer.

The Kiushu or Japan rice, now in process of introduction, has a short and thick kernel, and a thin hull; the percentage of bran and polish is small; the straw is still green when the grain is ripe; the yield is very large.

Lowland and Upland Rice.—While rice is chiefly grown on the lands that are low, level, and easily irrigated, there are varieties which can be grown on fertile uplands without irrigation. In the interior districts of India, China, and Japan upland rice is grown to a considerable extent, and experiments have demonstrated that it can be grown over large areas in the United States; but the crop is uncertain, and, in yield and quality, considerably inferior to lowland rice produced by irrigation.

Rice production in the United States is limited to the South Atlantic and Gulf States, where, in some sections, it is the principal cereal product. For nearly one hundred and ninety years after the production of rice into the United States, South Carolina and Georgia produced the principal portion, while North Carolina, Florida, Alabama, Mississippi and Louisiana grew only a limited amount. Within the last ten years Louisiana and Texas have increased the area devoted to rice to such an extent that they now furnish nearly three-fourths of all the product of the country.

For fifteen years prior to 1861 the annual production of rice in North Carolina, South Carolina, and Georgia had averaged more than 105,000,000 pounds of cleaned rice. Of this South Carolina produced more than three-fourths. But the industry in these States was wrecked by the war, and changed labor conditions, lack of necessary capital, and other causes have since prevented its full restoration. From 1866 to 1880, inclusive, the annual production of the three States averaged a little less than 41,000,000 pounds, of which South Carolina produced more than one-half. Since 1880 the average annual production has been, in round numbers, 46,000,000 pounds of cleaned rice, of which North Carolina produced 5,500,000, South Carolina 27,000,000, and Georgia 13,500,000 pounds.

Coincident with the breaking out of the civil war began the development of the rice industry in Louisiana. For a number of years the product was small, but during the seventies the industry began to assume large proportions, averaging nearly 30,000,000 pounds for the decade and exceeding 51,000,000 in 1880. In 1885 the production of Louisiana reached 100,000,000 pounds, and in 1892 182,000,000 pounds; but these were years of exceptionally large crops. The average crop of the State since 1880 has been, in round numbers, 86,000,000 pounds of cleaned rice.

The great development of the rice industry in Louisiana since 1884 has resulted from the opening up of a prairie region in the southwestern part of the State, and the development of a system of irrigation and culture which made possible the use of harvesting machinery similar to that used in the wheat fields of the Northwest, thereby greatly lessening the cost of production. In 1896, however, a new difficulty began to be felt. The varieties of rice which yielded best and were otherwise most satisfactory from a cultural standpoint under the new system proved inferior commercially because the percentage of grains broken in the process of milling was very large, and the proportion of "head rice," made up of the unbroken grains, was low. As the Japanese rices possess superior milling qualities, yielding a high percentage of head rice, it was desirable that they should be experimented with in this country. With this idea in view, the Department of Agriculture, in the spring of 1899, imported from Japan about 10 tons of Kiushu rice, which was distributed to experimenters in southwestern Louisiana, and elsewhere in the rice belt.

In rice culture the size of the fields depends on circumstances, chief among which are the slope of the land and the character of the soil as regards drainage. Fields range in size from 60 to 80 acres on the level prairies of southwestern Louisiana down to 1 or 2 acres along the banks of the Mississippi River. In oriental countries fields seldom contain more than a half acre. The entire surface of each field should be nearly at the same level so that the irrigation water will stand at about the same depth. Hence, where the slope of the surface is considerable, the fields must be made small. Fields must also be laid off in such a manner as to admit of effective drainage.

In coast-marsh and river-bottom culture a canal is excavated on the outer rim of the tract selected, completely inclosing it. The excavated dirt is thrown upon the outer bank to form a levee. The canal must be of sufficient capacity for irrigation and drainage. The levee must be sufficient not only to inclose the flooding water, but to protect the fields from encroachment of the river at all seasons. When practicable the rice lands are flooded from the river, and find drainage by a canal or subsidiary stream that enters the river at a lower level. The embankment must be sufficient to protect the rice against either freshets or salt water. Freshets are injurious to growing rice, not only because of the volume of water, but by reason of the temperature. A great body of water descending rapidly from the mountains to the sea is several degrees colder than water under the ordinary flow. Any large amount of this cold water admitted to the field not only retards the growth but is a positive injury to the crop. In periods of continued drought the salt water of the sea frequently ascends the river a considerable distance. Slightly brackish water is not injurious to rice, but salt water is destructive.

The tract of land selected and inclosed is then cut up by smaller canals into fields or subfields of suitable size, a small levee being thrown up on the borders of each. The entire tract is usually level, but if there should be any inequality care must be taken that the surface of each subfield be level. The main canal is 10 to 30 feet wide, about 4 feet deep, and connects with the river by flood gates. Through these canals boats of considerable tonnage have ready access to the entire circuit of the tract, while smaller boats can pass along the subcanals to the several fields. The subcanals are usually from 6 to 10 feet in width and should be nearly as deep as the main canal.

During the flooding period the ditches and canals become more or less filled with mud which flows into them with the water. As soon after harvest as possible the ditch banks should be cleared of foul grasses, weeds, or brush, and the ditches cleaned. The levees should be examined to see if they are in repair.

The entirely different method employed in the prairie regions of southwestern Louisiana and adjacent Texas will be described further on.

The time of plowing differs with different lands and circumstances, but in general it may be said that for wet culture plowing is done in the spring shortly before planting time. In the South Atlantic States, however, the land is often plowed or dug over with a hoe early in the winter. In some parts of southern Louisiana the land is so low and wet and the soil so stiff as to necessitate plowing in the water.

Some planters advocate shallow plowing for rice, because it appears to thrive best in compact earth. Even if this be granted, it does not prove the superiority of shallow over deep plowing. It has been demonstrated that the better the soil and the more thoroughly it is pulverized the better the crop. The roots of annual cultivated plants do not feed much below the plow line, so that it becomes evident that deep cultivation places more food within the reach of the plant. If pulverizing the earth deeply be a disadvantage, by reason of the too great porosity of the soil at seeding time, it can be easily remedied by the use of a heavy roller subsequently. If the soil is well drained deep plowing will be found profitable. Deep plowing just before planting sometimes brings too much alkali to the surface. The remedy for this is to plow a little deeper than the previous plowing just after harvest. The alkali will then be washed out before the spring plowing. The plow should be followed in a short time by the disk harrow and then by the smoothing harrow. If the land is allowed to remain in the furrow for any considerable time it will bake and can not be brought into that fine tilth so necessary to the best seed conditions. This is particularly true of rice land. If the best results are desired it will be advisable to follow the harrow with a heavy roller. The roller will crush the lumps, make the soil more compact, and conserve the moisture for germinating the grain, rendering it unnecessary to flood for "sprouting."

For dry culture the land is prepared very much as it is for a crop of oats.

Perfect drainage is one of the most important considerations in rice farming, because upon it depends the proper condition of the soil for planting. It may appear unimportant that a water plant like rice should have aerated and finely pulverized soil for the seed bed, but such is the case. Thorough cultivation seems to be as beneficial to rice as to wheat. Complete and rapid drainage at harvest always insures the saving of the crop under the best conditions and reduces the expense of the harvest.

Thorough drainage is even more essential for rice than for wheat, because irrigation brings the alkali to the surface to an extent that finally becomes detrimental to the rice plant. Alkali sometimes accumulates in the soil just below the depth of the usual furrow to such an extent that any plowing is dangerous to the crop. Experience has shown that there is but one effective way of disposing of these salts, and that is by thorough drainage and deep plowing. As the water drains away the excess of soluble salts is carried off. Now if the ditches are no deeper than the ordinary furrow it is evident that only the surface of the soil can be cleared. Either tiling must be employed or there must be plenty of open ditches, the main ones at least 3 feet deep.

Too great care can not be exercised in selecting rice for seed. It is indispensable that the seed should be free from red rice, grass, and weed seeds, uniform in quality and size of kernel, well filled, flinty, and free from sun cracks. Uniformity of kernel is more essential in rice than in other cereals, because of the polishing process.

The best time to sow rice differs in different sections and varies somewhat with varying conditions in the same section. It may be sown between the middle of March and the middle of May, but in most cases it should be sown by April 20 for best results. Sowing should take place as soon as possible after spring plowing. Care must be taken to plant the several fields at different periods, so that harvest will not be too crowded.

The amount of rice sown per acre varies, in different sections and with different methods of sowing, from 1 to 3 bushels per acre.

Three different methods of treating the seed are followed. Some let on just enough water to saturate the ground immediately after sowing and harrowing and at once draw off any surplus water. This insures the germination of the seed. Others sow and trust to there being sufficient moisture in the land to germinate the seed. This is sometimes uncertain and rarely produces the best results. A few sprout the seed before planting by placing bags of rice in water. This is sure to be a failure if the soil is very dry when the seed is sown. In case of planting in dry soil without following with water saturation, rolling the land after seeding and harrowing has been found beneficial.

The rice should be planted with a drill. It will be more equally distributed and the quantity used to the acre will be exact. The seeds will be planted at a uniform depth and the earth packed over them by the drill roller. It also prevents the birds from taking the seeds. The roller should precede the drill. If it follows the drill the feet of the horses, mules, or oxen drawing the roller will press some of the planted rice 4 or 5 inches deeper into the earth than the general average. Furthermore, the lumps of earth will prevent the uniform operation of the drill. In rice farming too much emphasis can not be placed upon the importance of thoroughly pulverizing the soil to a considerable depth; leveling with a harrow as perfectly as possible; crushing all the lumps and packing the surface to conserve the moisture; and planting the seed at a uniform depth.

Broadcast Sowing.—Broadcast sowing of rice is the method most in vogue in many localities, but it should be discontinued; the seed is never scattered with uniformity; some grains remain upon the surface and the remainder is buried by the harrow and the tramp of the team to depths varying from 1 to 6 inches. Rice sown broadcast does not germinate with any uniformity. Some seeds are taken by the birds, some are too near the surface and lack moisture to germinate, while others are buried too deep. In some instances the variation in the germination of the rice in the same field has been as much as eight weeks. Then at the harvest when the main portion is ready for the reaper, quite an amount of the rice is still immature. The product commands a very low price in the market, because the merchantable grain must sell at the price of the low grade. It requires much more care to produce a strictly first-class quality of rice than is found necessary in the production of any other cereal, and nearly every fall prime offerings are the exception.

Flooding is the most important distinctive feature of rice culture as compared with the culture of cereals generally. When it is considered that rice can be grown successfully without any irrigation whatever or with continuous irrigation from the time of sowing till nearly ripe, the wide scope there is for variation in practice will be realized.

Except where water is necessary for germinating the seed, flooding is not practised until the rice is 6 to 8 inches high. If showers are abundant enough to keep the soil moist it is better to delay flooding till the rice is 8 inches high, as there is considerable danger of scalding the rice when very young. At 8 inches high a sufficient depth of water can be allowed on the field to prevent scalding. The depth of water that should be maintained from the first flooding until it is withdrawn for the harvest depends upon other conditions. If the growing crop thoroughly shades the land, just water enough to keep the soil saturated will answer. To be safe, however, for all portions of the field, it should stand 3 to 6 inches deep, and, to avoid stagnation, it should be renewed by a continuous inflow and outflow. In case the stand of rice is thin the water should be deeper. A flow of water through the field aids in keeping the body of the water cool and in preventing the growth of injurious plants that thrive in the stagnant water. The water should stand at uniform depth all over the field. Unequal depths of water will cause the crop to ripen at different times.

In South Carolina under the usual method the water is let on as soon as the seed is covered, and remains on four to six days, till the grain is well sprouted. It is then withdrawn. As soon as the blade is up a few inches the water is sometimes put on for a few days and again withdrawn. The first water is locally called the "sprout water." After the rice has two leaves the so-called "stretch water," or "long-point flow," is put on. At first it is allowed to be deep enough to cover the rice completely—generally from 10 to 12 inches—then it is gradually drawn down to about 6 inches, where it is held twenty to thirty days. It is then withdrawn and the field allowed to dry. When the field is sufficiently dry the rice is hoed thoroughly, all grass and "volunteer" rice being carefully removed. After hoeing it remains without irrigation until jointing commences, when it is slightly hoed, care being used to prevent injury to the plants, and the water is then turned on again. During the time water is held on the rice it is changed at least every week to avoid becoming stagnant. When this occurs rice is liable to be troubled with the water weevil. This "lay-by flow," or final irrigation, continues until about eight days before the harvest, when the water is drawn off for the field to dry.

FERTILIZING.

Rice is not a great impoverisher of the soil, especially if the straw and chaff are regularly returned to it.

It has been claimed that the flooding of the rice fields restores to the soil as much nutritive material as

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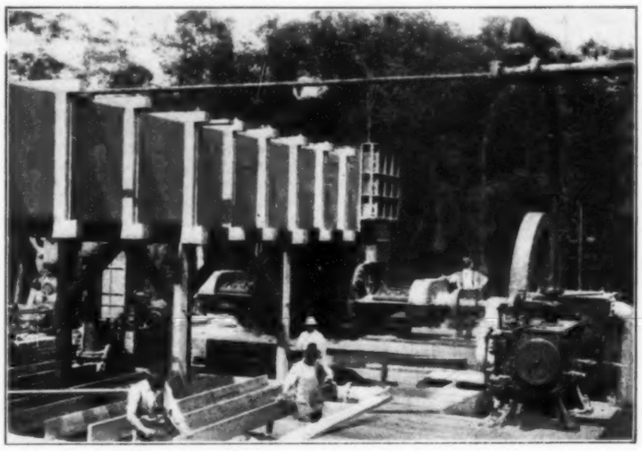
the rice crop removes. Where lands are flooded from rivers like the Mississippi or the Nile, which carry a large amount of silt, this may be true. It is not the case where flooding is done with pure water. The continued fertility of the rice field can only be maintained by restoring to the soil annually a portion of what the crop removes. Whether this can be more economically done by the use of commercial fertilizers and plowing under the rice straw, or by fallowing occasionally and using some renovating crop as a green manure is an economic question to be determined by each planter according to the conditions presented. Repeated trials of commercial fertilizers have almost invariably shown gains in the quality and quantity of the crop more



PUMPING STATION.

than sufficient to cover the cost. Summer fallowing, where it can be practised, is, in addition to its renovating effect, a substantial aid in destroying noxious grasses and red rice.

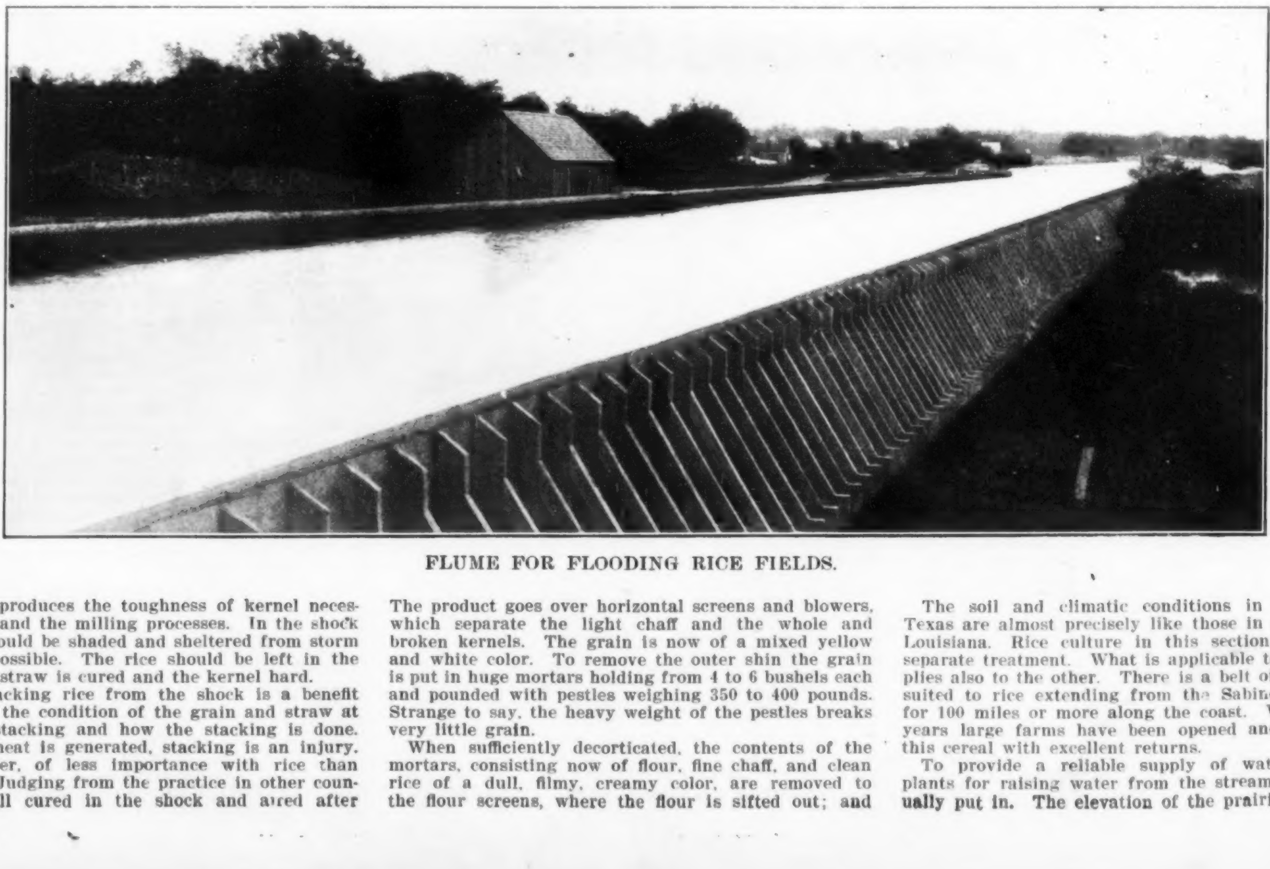
There is very little exact information on the subject of fertilizers for rice. In Japan and other oriental countries a large proportion of the rice lands is thoroughly fertilized in the fall with straw, leaves, rice hulls, fish, and night soil. The fields are planted to wheat or vetches for the winter crop, followed the next spring by rice without additional manures.

HARVESTING.

Reaping machines are generally used in the prairie district of Louisiana and Texas.

Where the use of reaping machines is impracticable, the sickle is the implement commonly used in harvesting rice. The rice is cut at 6 to 12 inches from the ground, and the cut grain is laid upon the stubble to keep it off the wet soil and to allow the air to circulate about it. After a day's curing the grain is removed from the field, care being taken not to bind it while wet with dew or rain. The smaller the bundles the better will be the cure.

Care in shocking is also important. Thirty per cent of the crop may be lost by improper shocking. The following directions will aid: First, shock on dry ground; second, brace the bundles carefully against each other, so as to resist wind or storm; third, let the shock be longest east and west and cap carefully with bundles, allowing the heads of the capping bundles to fall on the north side of the shock to avoid the sun. Exposure of the heads to sun and storm is a large factor in producing sun-cracked and chalky kernels, which reduce the milling value. Slow curing



FLUME FOR FLOODING RICE FIELDS.

in the shade produces the toughness of kernel necessary to withstand the milling processes. In the shock every head should be shaded and sheltered from storm as much as possible. The rice should be left in the shock till the straw is cured and the kernel hard.

Whether stacking rice from the shock is a benefit depends upon the condition of the grain and straw at the time of stacking and how the stacking is done. If too much heat is generated, stacking is an injury. It is, moreover, of less importance with rice than with wheat. Judging from the practice in other countries, rice well cured in the shock and aired after thrashing ought to keep in the bin without heating.

The primitive methods of "flailing," "treading out," etc., have largely given place to the use of the steam thrasher. At the commencement of the thrashing examination should be made to see that there is no avoidable breakage of the grain. If the rice is damp when delivered from the machine, it should be spread upon a floor and dried before sacking, so as to be in the best condition for the market, for color of grain affects the value.

YIELD OF RICE.

The yield of rice varies with conditions of soil and climate and methods of culture. The commercial standard weight of "rough rice" is 45 pounds to the bushel. The product is usually put up in sacks or barrels of 162 pounds each.

In South Carolina and Georgia the average yield is given as 8 to 12 barrels. Good lands properly managed will give a considerably larger yield.

The yield in southwestern Louisiana is said by good authority to range from 8 to 18 barrels per acre.

In a report made by planters to the Savannah Rice Association, January 28, 1882, the average yield to the acre is placed at 30 bushels, and the annual cost of cultivation, including the interest on the land, at $35 per acre. In a report made by prominent rice planters to the House Committee on Ways and Means in January, 1897, the average yield to the acre is placed at 32 bushels, and the cost of production is fixed at $24. If we take the latter estimate, the cost to the planter in the Atlantic States of raising 100 pounds of rough rice is $1.66, or $2.69 per sack of 162 pounds. Of course this is only an average, the cost being much less in some instances and in others much greater.

The rice as it comes from the thrasher is known as "paddy" or "rough rice." It consists of the grain proper with its close-fitting cuticle roughly inclosed by the somewhat stiff, hard husk. The object of milling is to produce cleaned rice by removing the husk and cuticle and polishing the surface of the grain. The hulls or chaff constitute about 20 per cent of the weight of the paddy.

The improved processes of milling rice are quite complicated. The paddy is first screened to remove trash and foreign particles. The hulls, or chaff, are removed by rapidly revolving "milling stones" set about two-thirds of the length of a rice grain apart. The product goes over horizontal screens and blowers, which separate the light chaff and the whole and broken kernels. The grain is now of a mixed yellow and white color. To remove the outer shin the grain is put in huge mortars holding from 4 to 6 bushels each and pounded with pestles weighing 350 to 400 pounds. Strange to say, the heavy weight of the pestles breaks very little grain.

When sufficiently decorticated, the contents of the mortars, consisting now of flour, fine chaff, and clean rice of a dull, filmy, creamy color, are removed to the flour screens, where the flour is sifted out; and thence to the fine-chaff fan, where the fine chaff is blown out. On account of the heat generated by the heavy frictional process through which it has just passed, the rice next goes to the cooling bins. It remains here for eight or nine hours, and then passes to the brush screens, whence the smallest rice and what little flour is left pass down on one side and the larger rice down the other.

The grain is now clean and ready for the last process—polishing. This is necessary to give the rice its pearly luster, and it makes all the difference imaginable in its appearance. The polishing is effected by friction against the rice of pieces of moose hide or sheepskin, tanned and worked to a wonderful degree of softness, loosely tacked around a revolving double cylinder of wood and wire gauze. From the polishers the rice goes to the separating screens, composed of different sizes of gauze, where it is divided into its appropriate grades. It is then barreled and is ready for market.

In mills more recently erected the foregoing process has been modified by substituting the "huller" for the mortar and pounder. The huller is a short, cast-iron, horizontal tube with interior ribs and a funnel at one end to admit the rice. Within this tube revolves a shaft with ribs. These ribs are so adjusted that the revolution of the shaft creates the friction necessary to remove the cuticle. The rice passes out of the huller at the end opposite the funnel. It resembles externally a large sausage machine. It requires six hullers for each set of burs. The automatic sacker and weigher is used instead of barreling, sacks being preferred for shipping the cleaned rice.

With the above modification of the milling processes considerable reduction has been made in the cost of the mill. Mills of a daily capacity of 60,000 pounds of cleaned rice can now be constructed at a total cost of $10,000 to $15,000.

RICE CULTIVATION IN SOUTHWESTERN LOUISIANA AND SOUTHEASTERN TEXAS.

In 1884 and 1885 a few farmers from the Northwestern prairie States settled on the great Southern prairie which extends along the coast from the parish of St. Mary in Louisiana to the Texas line—about 140 miles. Finding that rice, which had been grown for many years for home consumption, but by oriental methods, was well suited to the conditions of agriculture here, they commenced immediately to adapt the agricultural machinery to which they had been accustomed to the rice industry. The gang plow, disk harrow, drill, and broadcast seeder were readily adjusted, but the twine binder encountered a number of serious obstacles. However, by the close of 1886 the principal difficulties had been overcome. Wherever prairies were found sufficiently level, with an intersecting creek which could be used to flood them, they were surrounded by a small levee thrown up by a road grader or by a plow with a strong wing attached to the moldboard extending it 4 or 5 feet. These levees were usually 12 to 24 inches high, and the interior ditch was 12 to 18 inches deep and 4 to 5 feet wide. Very few interior ditches were made for drainage. The land was so level that fields of 40 or 80 acres were common. Large crops were produced. The prairies were practically free from injurious grasses, and the creek or river water was soft and bore no damaging seeds to the fields. The rice fields were handled like the bonanza wheat farms of Dakota, and fortunes were made. Levees were cheaply constructed; little attention was paid to drainage, more than to remove the surface water; shocking, stacking, and thrashing were done in a very careless manner; the main object being, apparently, to plant a large acreage and secure a certain number of bushels, regardless of quality. Ultimate failure was certain, but it was hastened by drought. A succession of dry years followed. The creeks failed, and reservoirs were found to be expensive and unreliable.

The soil and climatic conditions in southeastern Texas are almost precisely like those in southwestern Louisiana. Rice culture in this section requires no separate treatment. What is applicable to the one applies also to the other. There is a belt of prairie well suited to rice extending from the Sabine River west for 100 miles or more along the coast. Within a few years large farms have been opened and devoted to this cereal with excellent returns.

To provide a reliable supply of water, pumping plants for raising water from the streams were gradually put in. The elevation of the prairies above the

streams varies from 6 to 38 feet, the larger portion being from 15 to 25 feet. At first, farms along the streams and lakes were irrigated; gradually large surface canals were constructed.

Irrigating canals were started in a small way in Acadia Parish, La., in 1890. In 1894 a canal 40 feet wide was built for 15 miles with 10 miles of laterals. This was followed by the Crowley Canal, which is now 35 feet wide and 8 miles in length, and has 10 miles of lateral lines. The Riverside Canal was the next, and now has several miles in operation. These enterprises have grown steadily until there are now 9 canals in Acadia Parish, with an approximate length of 115 miles. There are about 25 irrigating canals in Acadia, Calcasieu, Cameron, and Vermilion parishes, with a total length of over 400 miles of mains and probably twice that extent of laterals, built at a total cost of about $1,500,000. In nearly every township there are one or more ridges slightly above the surrounding land. On these surface canals are built from 20 to 150 feet in width, according to the area to be watered. The sides of the canal are raised from 4 to 5 feet with plows and scrapers or with grading machinery. Grading machines work very well, as the soil is a loam or a clay loam free from stones. Side gates are inserted in the embankment as frequently as necessary. Laterals are run from the main canal to accommodate remote farms. Powerful pumping plants are erected on the bank of the river at the head of the surface canal. These canals, where well constructed and operated, prove entirely successful and make the rice crop a practical certainty over a large section of country. They range in irrigating capacity from 1,000 to 30,000 acres. The usual water rent charged the planter by the canal company is 324 pounds of rough rice per acre watered.

Scarcely had the surface canals been accepted as a success when southwestern Louisiana was startled by the announcement that there were strata of gravel at 125 to 200 feet under the surface of the entire section, containing an unlimited supply of water, which would, of its own pressure, come so near the surface that it could be readily pumped. This was received with considerable incredulity at first, but repeated tests have proved that there is a bed of gravel nearly 50 feet in thickness underlying this section of Louisiana, which carries a large amount of soft water with sufficient pressure to bring it nearly to the surface. Pipes of 2, 3, 4, 6 and 8-inch size have been sunk to the gravel and pumped continuously for months without diminution of the supply. The water is soft, at a constant temperature of about 70 deg., and absolutely free from injurious seeds or minerals. Such is the facility with which these wells are made that a 6-inch tube has been put down to the full depth required—200 feet—in fourteen hours. Thus far it has been found that a 2-inch pipe will furnish sufficient water to flood 10 acres of rice and a 6-inch pipe will flood 80 to 90 acres. Any number of wells may be made, and even if no more than 20 or 30 feet apart, one does not diminish the amount of water obtained from another. It is probable that such wells will become common for the irrigation of other crops than rice.

A 6-inch well will furnish a constant stream for a 4 to 5 inch pump. A system of such wells may be put down 30 to 40 feet apart and each one will act independently and furnish as much water as if it stood alone. Such a combination of wells may be united just below water level and all be run by one engine and pump. Water rises naturally in these wells to within 20 feet of the surface, and a number of flowing wells have been secured. The lift is not greater than from rivers, lakes, or bayous into canals. Eight 4-inch wells united at the top can be run by one 16-inch pump and a 50-horsepower engine, and will flood 1,000 acres of rice.

The total cost of an irrigating plant sufficient for flooding 200 acres is from $1,500 to $2,500. It requires about seventy days' pumping for the rice season.

The operations of harvesting and thrashing the rice crop in southwestern Louisiana are performed largely with the McCormick self-binder and the steam thrasher. The use of the former is favored by the size of the fields, and by the character of the soil. The use of the latter is a cheap, rapid, and effective method of separating the rice from the straw. Without the use of such machines the large cultural operations of this section would be impossible.

The outlook for the further extension of the industry is very promising. According to the best estimates there are about 10,000,000 acres of land in the five States bordering the Gulf of Mexico well suited to rice cultivation. The amount which can be successfully irrigated by present methods, using the available surface and artesian flows, does not exceed 3,000,000 acres. The balance of the land could probably be brought into cultivation were it necessary, but the cost would, perhaps, be prohibitive at present prices. Three million acres is a conservative estimate of the amount which can be successfully irrigated. The best results require rotation of crops; consequently only one-half of that amount, or 1,500,000 acres, would be in rice at one time. At an average yield of 10 barrels (of 162 pounds) per acre, 1,500,000 acres of rice would produce nearly 2,500,000,000 pounds of cleaned rice, nearly six times the amount of our present consumption. There is no satisfactory reason why the United States should not grow and mill all of its own rice and become an exporter.

The employment of machinery in the rice fields of the Southwest similar to that used in the great wheat fields of California and the Dakotas is revolutionizing the methods of cultivation and greatly reducing the cost. The American rice grower, employing higher-priced labor than any other rice grower of the world, will ultimately be able to market his crop at the least cost and the greatest profit. If, in addition, the same relative improvement can be secured in the rice itself, if varieties which yield from 80 to 90 per cent of head rice in the finished product can be successfully introduced, American rice growers will be able to command the highest prices for their product in the markets of the world. In view of the success in this direction of the Kiushu rice experimentally introduced by the Department of Agriculture, more than a hundred tons of this rice have been ordered from Japan by Louisiana planters for the season of 1900.

MECHANICAL MANUFACTURE OF BOTTLES.

The manufacture of glassware is one of the industries most detrimental to the health of the workmen employed in it. Despite the precautions that may be taken, the extremely high temperature of the furnaces (about 2,192 degs. F.) causes a considerable disengagement of heat by radiation and conductivity, while, on the other hand, the glass in a fused state is at a temperature of from 1,292 to 1,472 degs. F., and it is hence impossible to prevent radiation and conduction from occurring. Under such conditions the temperature of the atmosphere of the rooms in the vicinity of the furnaces varies between 104 and 122 degs., and whatever be the lightness of their clothing, the workmen are in a constant state of perspiration. The inconveniences and ailments that such abnormal temperature may involve can readily be perceived. Moreover, the reflection of light and heat from the glass when fused is extremely fatiguing to the sight and, in the long run, causes a special disease in the workmen. Besides, this continual stay in a superheated atmosphere leads the glass founders to indulge to excess in drinking which adds its disastrous effects to those injurious ones that are a natural consequence of the nature of the work.

Again, the blowing of the glass also is accompanied with serious inconveniences, especially for workmen engaged in the manufacture of bottles. The rough turning is very fatiguing. The workman has to give the mass of glass, which is often quite heavy, a rapid rotary motion lasting for hours, since one man with his two helpers makes at least 600 bottles per day of from 10 to 12 hours work. Since each bottle weighs about 19 or 20 ounces, it will be seen that the amount of work done is very considerable; and, if we reflect that it has to be performed in an atmosphere of from

The reason that M. Boucher has reached so satisfactory a result is that he has endeavored to so combine his mechanisms as to make them perform as far as possible the various manual operations involved in the manufacture of bottles. Human blowing, moreover, is replaced by compressed air, which, according to the periods of the manufacture, is used under two different pressures.

The machine consists of a rectangular cast iron frame, at each end of which is fixed a support carrying the different pieces employed in the manufacture of the bottle. A number of these may be easily exchanged according to the models to be manufactured, such, for example, as the molds used for forming the collar, the measuring mold for the reception of the proper quantity of molten glass, the intermediate molds in which the rough model is successively blown, and, finally, the finishing mold in which the internal form is exactly that of the bottle or other object to be manufactured.

Fig. 1 shows the machine at the moment at which the series of operations is to be begun. The measuring mold, *A*, is formed of two parts that may be separated or brought together at will by means of bevel gearing, *a*. At the lower part is the collar mold, *B*, in the interior of which slides a mandrel having the internal dimensions of the neck of the bottle, so as slightly to perforate the entrance of the neck. The molten glass, taken from the furnace by means of an iron rod, is poured into the measuring mold previously heated to a temperature of from 1,112 to 1,292 degs. F. The molder, seated in front of his machine, then applies the compressor, *C*, to the upper end of the mold and, pressing upon a pedal, causes air compressed to about 10 pounds to the square inch to enter above the glass, which is as yet extremely hot and almost liquid. This latter descends to the lower mold, into

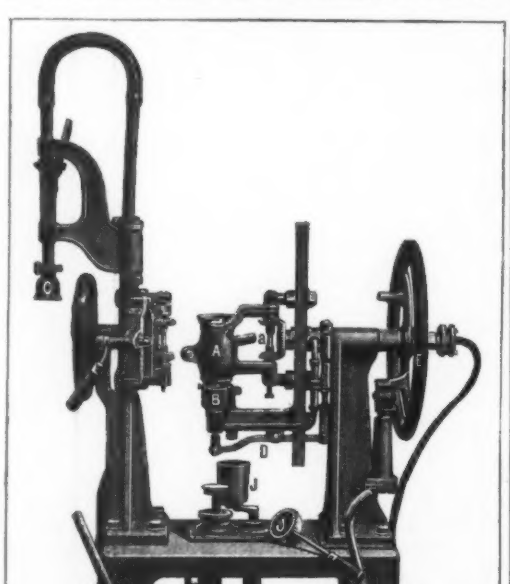


Fig. 1.—THE BOUCHER MACHINE FOR THE MANUFACTURE OF BOTTLES READY FOR THE RECEPTION OF THE MOLTEN GLASS.

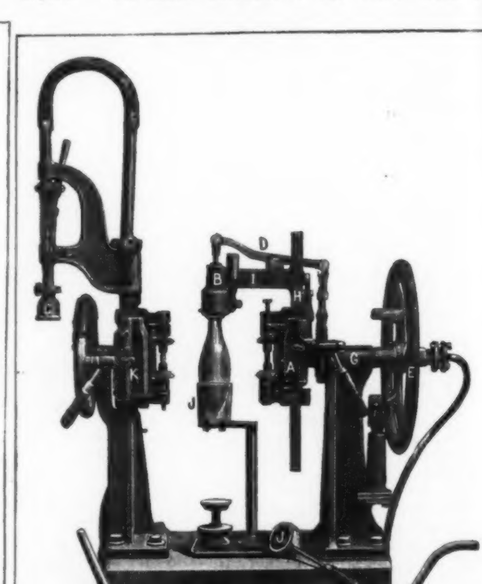


Fig. 2.—BOUCHER BOTTLE MACHINE AS IT APPEARS IN OPERATION.

104 to 122 degs. F., we can appreciate what fatigue must result therefrom to those upon whom it devolves.

Blowing by pipe into the fused glass rapidly involves the burning of the tissues of the throat and cheeks, and soon leads to a rupture thereof. Such work frequently causes pulmonary phthisis, or at least often affects the respiratory tracts. Finally, and this is not the least danger, the transmission of contagious diseases to the workmen by the pipe is unfortunately very frequent, a bad state of the tissues of the mouth greatly facilitating such transmission and rendering it still more dangerous.

Under such circumstances the fact that glass blowers never grow to be old and are obliged to abandon their trade at the age of about forty at the most is easily explainable.

Inflammation of the lungs, phthisis, weakening of the muscles, anæmia and blindness are, in fact, the terrible afflictions that attack them, and which they can escape only exceptionally. So, for some time past, and with a philanthropic end in view (and at the same time, an economical one, since glass makers are pretty well paid), an endeavor has been made to manufacture glass mechanically and especially to do away with blowing, which is so dangerous to the workmen.

Although numerous systems have been proposed, the practical results obtained up to the present time have not come up to the expectations of their inventors.

M. Boucher, a master glassmaker of Cognac, has recently devised a process of manufacture that seems as if it ought to give satisfaction both to proprietors and workmen, since it not only does away with the danger attending the operation of blowing and partially with that due to the reflection from the fused glass, but also permits of a more economical and rapid production. The Société d'Encouragement à l'Industrie Nationale, moreover, has recognized the value of this process by awarding its inventor a gold medal.

which the mandrel is gently introduced by means of an eccentric that acts upon a lever, *D*. The neck is thus molded perfectly. By means of a handwheel, *E*, the workman immediately inverts the two molds and opens the measuring one. As the mass of glass is suspended by the neck (Fig. 2) it elongates freely. This causes in the fluid mass a sort of spontaneous reheating that gives the glass a luster. When the rough-shaped bottle is sufficiently elongated, the workman introduces it successively into the intermediate molds, *J*, and introducing air through the neck at a pressure of about 3.5 pounds to the square inch, gradually increases the volume of the mass. This compressed air is led through the pipe, *F*, and passages arranged in the arms, *G H I* (Fig. 2). The glass then being placed in the finishing mold, *K*, another compression causes it to assume the exact form thereof by forcing it against the walls. The bottle, now finished, is left in the mold for a couple of seconds, after which it is removed and carried by an apprentice to the annealing furnace. This machine, the operation of which is very simple, permits of manufacturing all kinds of bottles, flasks, bowls and other objects, especially those having a neck of small size.

With two machines, two operatives and one boy for carrying the molten glass can manufacture 3,600 bottles in 24 hours, say 1,800 bottles per machine, at a cost of 40 cents per hundred, against 70 cents by the old method; whence a saving of 30 cents per hundred. Moreover, the product obtained is of very excellent quality, since the glass is more regularly distributed and the intermediate molds permit of regulating the thickness of it. As regards strength, the results of tests made in one of the largest bottle works in Spain show that the bottles manufactured with the Boucher machine have a resistance of 338 pounds to the square

inch, while bottles of the same weight and shape manufactured at the same moment with the same glass by selected workmen offered a resistance of but 290 pounds.

As for the working conditions, they are thoroughly transformed. The machine may be placed at any point whatever of the room so as to protect the workman from the glare of the furnace containing the fused glass. The helper has no longer any need of a heavy pipe for taking up the glass, but simply of a very light rod. Finally, the blowing by mouth is entirely done away with. The molder has nothing to do but to cut the glass that the helper has introduced into the mold and to operate pedals or handles for changing the different molds and the regulation of the compressed air. For the above particulars and the illustrations we are indebted to La Nature.

THE "PARABELLUM" AUTOMATIC PISTOL.

THE ballistic efficiency of the small-caliber firearms having been demonstrated by Lieut.-Col. Wurstemberger, the credit belongs to Switzerland for having introduced a rifle of 10.2 mm. caliber as early as 1851, leading in this respect the armies of all other powers. Switzerland was also the first country to adopt repeating rifles of 10 mm. caliber (Vetterli's system) in 1868, that is to say, at a time when most armies were still actively converting their old muzzle-loading rifles of 17-18 mm. caliber into breech-loading rifles; the course thus worked out being followed by Germany only eighteen years later, when the latter country, under the pressure of its strained political relations with France, where Boulanger was then exerting every effort to bring a war of retaliation, suddenly adopted the repeating rifle model 1871-84. And again we find Switzerland in the front rank, introducing at the end of last year an automatic pistol in place of the Schmidt system revolver, adopted in 1878, opening thus the path for the introduction of portable automatic firearms among the weapons of war. We are convinced that sooner or later all armies will follow the example of Switzerland, not only with regard to handarms, but with regard to shoulder-arms as well. The powers will be compelled to take such a course, not because the firing rapidity of the automatic rifles and pistols exceeds that of the repeaters, but on account of the fact that it is possible for the marksman to retain his weapon in a leveled position and to watch uninterruptedly his aim and the effects of the shots, as long as there are cartridges in the magazine. No further proof is needed to show that advantages have thus been obtained which justify the prospects that the pistol in question will have a higher efficiency in action than other weapons, which divert the attention of the marksman from his aim after every shot.

The Parabellum pistol, adopted by the Swiss government, is manufactured by the Deutsche Waffen und Munitionsfabriken (German Arms and Ammunition Works) in Berlin, according to designs furnished by Mr. Lueger, the chief engineer of said works. The pistol in question represents a series of improvements on the Borchardt pistol.

There has been retained in the new weapon the toggle-joint or knee-joint, constituting a characteristic part of the breech mechanism in the old pistol; however, nearly in every other respect changes have been made. Like the former pistol, the new weapon belongs to that class of automatic firearms in which the breech is firmly locked, while the projectile passes the barrel, the opening of said breech occurring only after the projectile has left the barrel; it differs therefore in this respect from the Browning pistol.

The movement for opening the breech is effected in such a manner that, when the pistol is fired, the recoil created by the gases forces barrel, *l*, screwed into the bifurcated receiver, l^2 (Fig. 6), to slide backwardly in the grooves of butt, 17, firmly grasped by the hand of the marksman, until thrust-piece, *r*, strikes against the end of its groove, *o*, in the butt. During the described rearward motion, the toggle-joint remains at first straight, until catch, 8 (Fig. 4), arranged on the right-hand link-cheek, 6, of the toggle lever, has receded behind a catch, 17*l*, in the butt, permitting the toggle-joint to spring up; said springing up of the toggle-joint being brought about by the link-cheeks, *cx*, which rise in the rearwardly ascending sliding surface of the lateral portions constituting the two back-sides of the butt. When the rear link of the

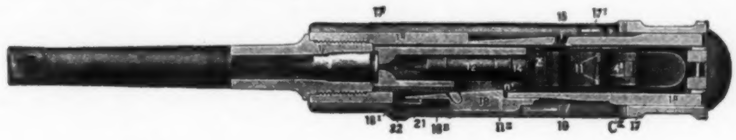


FIG.5.

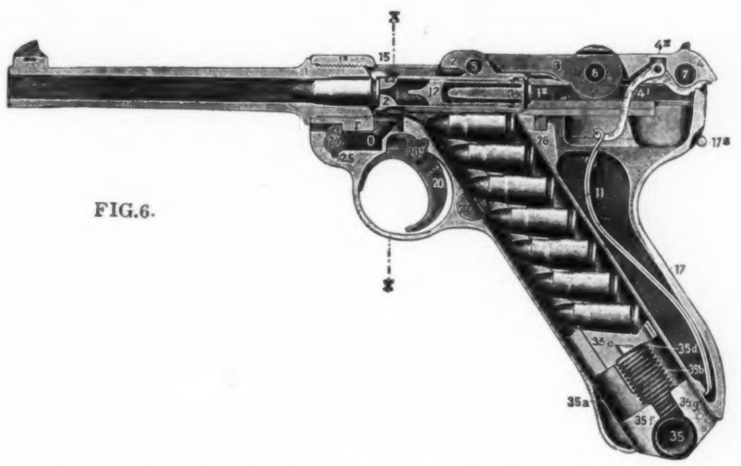


FIG.6.

FIG. 5.—Horizontal axial section. FIG. 6.—Longitudinal section through the entire cocked pistol.

THE "PARABELLUM" AUTOMATIC PISTOL.

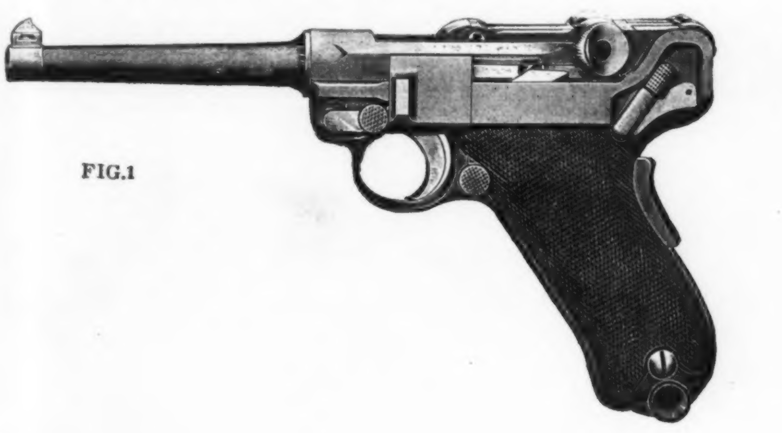


FIG.1

FIG. 2.

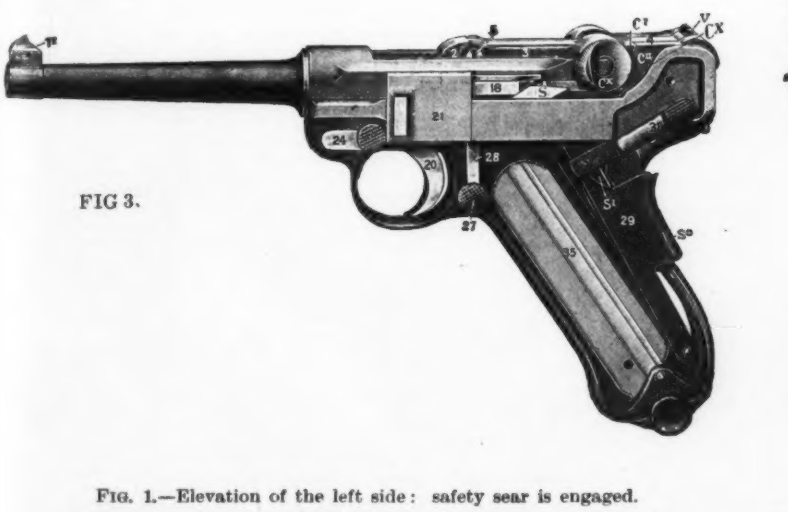


FIG 3.

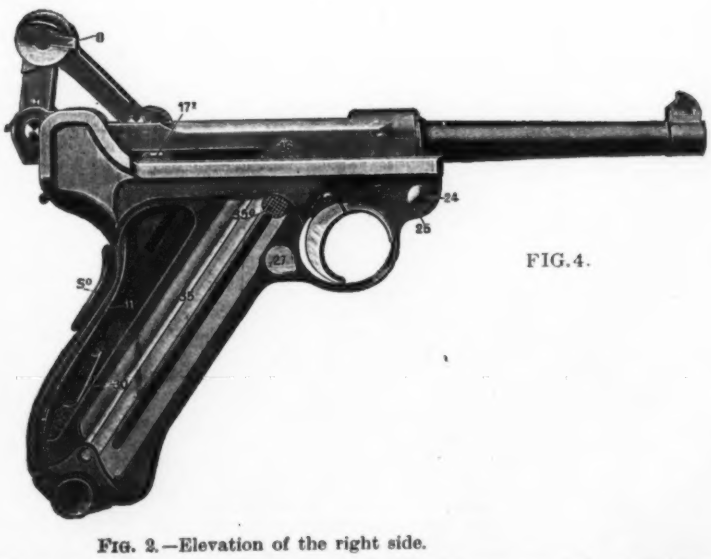


FIG.4.

FIG. 1.—Elevation of the left side: safety sear is engaged.

FIG. 2.—Elevation of the right side.

FIG. 3.—Perspective of the left side: butt side-pieces are removed; catch of safety sear is disengaged.

FIG. 4.—Perspective of the right side: butt side-pieces are removed; magazine is empty; breech-block catch-link is engaged.

THE "PARABELLUM" AUTOMATIC PISTOL.

toggle-joint is thrown upward, it turns around the pintle, 7, arranged within the frame, this turning movement being stopped as soon as the nose of this part strikes against the rear end of the butt. As the toggle-joint rises, it pulls back the forward link, 3, and the breech-block, 2, connected therewith by means of joint, 5. The toggle-joint will rise until nose, *D*, of the forward link moves back the firing pin, 12, working within the breech-block, and thus cocks the firing-pin spring. During the rising movement of the toggle-joint, the rear link has drawn back and thus cocked the recoil spring, *H* (Fig. 6), by means of coupling link, *4I*, joined thereto. The pressure of the recoil spring is relaxed automatically, as soon as the backward momentum of the operative parts of the breech and the recoil of the discharge have been exhausted, in such a manner that it draws the rear link down and straightens it. The breech-block is thus driven forward and draws along the uppermost cartridge, brought up from the magazine into the breech by the cartridge-feeder, 35, and the cartridge-feeder spring; it rams this cartridge home into the barrel, and advances together with the latter and with the breech-parts up to the locking-bolt, 24, leaving the pistol ready to be discharged. Only the firing pin is retained by the trigger-bar, 18 (Fig. 5), until released by pressing the finger against trigger, 20 (Fig. 6). The firing pin is then thrown forward by the firing-pin spring against the percussion-cap of the cartridge, discharging thus the shot, which creates the energy for effecting again all the above-described movements. The empty cartridge-shell, which remains now in the barrel, is withdrawn by the extractor, 15, and then ejected from the pistol by the ejector, 16. As soon as the last cartridge from the magazine has been used, the automatic locking of the pistol is interrupted in such a manner that a guide-knob on the right side of the pistol presses the breech-block catch-link, 26, into the recess, *C*, of the breech-block (Fig. 6). The breech is thus caused to remain open (Fig. 4), also if the magazine is removed for refilling and again inserted. In order to make the pistol ready for firing, the toggle-joint is drawn back a little and then springs forward again.

A remarkable feature is the safety device, which prevents at any time, automatically, the breech from making the slightest movement, being thus a positive safeguard against any unintentional discharging of the weapon as long as the latter is not in the closed hand of the user. In order to fire the pistol, its butt must be firmly grasped, so that the automatic safety-sear, 29 (Fig. 3), against which a spring bears, is pressed inward, releasing thus the trigger-bar which it retains. In this manner the safety-sear is released perfectly automatically; however, if this automatic action is not required, safety catch, 31 (Fig. 3), is moved down and places itself against a projection of the safety-sear, thus preventing any movement of the latter as well as of the barrel.

The dismounting of the pistol, as far as is necessary for ordinary use, can be done without any tools, except the butt side-pieces (Fig. 1), which can only be removed with the aid of a screw-driver.

The caliber of the Parabellum pistol is the same as of the Borchardt pistol, 7.65 mm.; length of the barrel is 122 mm.; length of the entire pistol, 237 mm.; weight of pistol is 835 grs.; weight of empty magazine, 55 grs.; weight of magazine, filled with eight cartridges weight 10.8 grs. each, 139 grs.; the projectile, consisting of a steel plate jacket with hard lead core, weighs 6 grs. and attains with smokeless powder charges, weighing 0.33 gr., an initial velocity of 350 m. (10 m. before muzzle), its maximum range being approximately 1,800 m. with an agle of elevation of about 27 deg. 30 min. The bullets penetrate, at a range of 50 m., 160 mm. in beechwood and 8 mm. in iron plate. If filled magazines are at hand, the pistol can be fired at the rate of about 100 shots per minute during mechanical rapid firing.

The somewhat strange appearance of the Borchardt pistol, with vertically arranged butt and backward-extending frame, has been modified in the Parabellum pistol, and the latter can thus be handled with much more convenience; it balances perfectly in the hand, its ballistic efficiency is far superior to that of the Browning pistol, so that it can disable the opponent also in case the bullet hits parts of the equipment, such as coats, cartridge-boxes, leather-belts, etc., or if the enemy seeks protection under slight cover, such as boards, fences, hedges and the like.

For our illustrations and the accompanying description we are indebted to Prometheus.

THE PRACTICAL PROCESS OF MAKING ELECTRICAL ENGINEERS.*

By FRANK HIX FAYANT.

AT the gateway of the historic Mohawk Valley, where, not many years ago, the sturdy Dutch frontiersmen blazed a bloody trail through the forest kingdom of the Six Nations, there sprang up, with miraculous rapidity, in the closing years of the nineteenth century, the greatest electric shops in the world. On the lowlands, where a few farmers had gained a pittance raising vegetables for the then sleepy village of Schenectady, ten thousand men, at furnace and forge, and bench and lathe, now earn seven million dollars a year in wages. Here, in these wonder shops, is being solved the greatest of all material problems—that of the economical production of power. With marvelous mastery of the mysterious energy of electricity, the nature of which is unrevealed to man, the explorers in this new domain of engineering have harnessed nature's forces at mountain-side and mine-pit, and carried the captive energy hundreds of miles to give light and heat, to drive locomotives, and to turn wheels of industry. Gigantic generators of electric energy, and mighty motors that transform the unseen pulsations into power, are here created, with scientific precision, for service to the utmost bounds of civilization. The products of this once Indian trading post now find their way from Tierra del Fuego to the North Cape, from the cataract of Niagara to the falls of sacred Cavery in India; from the summits of the Andes to the deepest drifts of the Calumet and Hecla; from Charing Cross to Cairo, and from the bedside of the aged Pope to the palaces of the boy Sultan of Morocco and the domain of the Shah of Persia. Among the ten thousand workers there are five hundred clear-eyed young men, clad in rough working garb and begrimed with dust and grease. They are the world's future electricians. All of them are ambitious to achieve international distinction in electrical engineering; some of them will become the scientific leaders of the mid-century; one or two may gain immortal renown. Drawn from the institutions of higher learning—universities and technical schools, not only of the Americas, but also of a score of foreign countries—these young men are the pick of the brains and energy of the rising generation. After four years of rigorous study in university laboratories, shops, and lecture rooms, where they become versed in the theory of physics and chemistry, of mathematics and mechanics, in the broad principles of mechanical and electrical engineering, and also in the art of machine design and the best practice in foundries and smithies, in wood-working and machine shops, these embryo world-leaders, from the four quarters of the globe, put on working clothes and begin life's battle under the strenuous law of the survival of the fittest.

In electricity the unattainable of yesterday is the achievement of to-day, the commonplace of to-morrow. Brilliant economy becomes useless waste. The pace is so swift that the engineer who lags is lost; only the master minds can hope to keep their places in the advance. More than this, a great industrial organization, like that at Schenectady, based on electrical engineering, must have at its command an inexhaustible storehouse of brains as well as of copper and iron, else its millions of invested capital would go to waste in the obsolete. So it is that these shops seek the young men of promise in the universities the world over, and offer to them opportunities to supplement the theory of the schools by the practice of the shops in the very home of the electrical industry. From among these finely trained men (the newcomers, each year, after the June commencements, outnumber the graduates of our greatest technical schools) are drawn the directing minds of the great electrical industry. Not only do these shops profit by this American system of highly specialized training, but all the world's industrial nations are thus enabled to keep in touch with American electrical progress. The Old World, which, slowly, through the centuries, developed the theory of electricity, is awakening to its marvelous industrial possibilities, revealed, in a decade, in the New World. And so proud England, fearful of losing her hold on international trade; industrious Germany, plunging with indomitable Teutonic energy into commercial conquest; thrifty France, with her love for the pursuit of the unknown and the unattainable; and mighty Russia, covering an untraveled continent with a network of steel—all the great nations are sending their chosen youth to learn the secrets of the all-powerful electric energy.

When a young college graduate enters the shops, no matter what are his scholastic attainments, his advancement depends wholly on the merit of his work from day to day. A device that will increase the efficiency of a piece of machinery by the smallest fraction is more highly prized than the most learned degree. Results are wanted. Original research is rewarded. Every opportunity is given the individual to direct his energy into the most favorable channel. Some men are born to lead, but more seem destined to follow. Industrial leaders—captains of industry, of the first order—are few. They are worth almost any price. When men of executive ability are discovered among the five hundred young engineers, they are as carefully nurtured as the eldest sons of royal families. Specializing, likewise, is strongly encouraged; for, in the broad field of electrical engineering, no man can hope to be master of all. The brilliant work is done by the specialists. It is peculiarly characteristic of our American life that we specialize in everything. A large measure of our industrial supremacy is due to this western practice of training the individual and building the machine to do one thing as well as it can be done. A "jack-at-all-trades" is a nobody.

As our government pays young men to learn the art of war at West Point, so do these shops offer a salary to each collegian in their school of engineering. It is insignificant, at first, scarcely enough to pay the living expenses of the most frugal. All the young engineers receive twelve and one-half cents an hour at the start. When their services are worth more, they are paid more. One man may be in a position of responsibility, at the end of a few months, with a salary of several thousand dollars a year, while his college classmate is plodding along for wages of a few dollars a week. To the men who show high ability to do executive work, positions are open, as heads of departments, as engineers in charge of foreign installations and new stations, and as managers of new shops, with salaries ranging from $2,500 to $25,000 a year. As consulting engineers, even greater incomes may be earned. All of these young engineers keep their eyes open for new ideas, and some of them, through their inventions, have made themselves independently rich. No other field of industry offers such rich promise to the inventor as does electrical engineering. It is fraught with a myriad possibilities.

America's captains of industry, almost invariably, have risen from the ranks; and, although electricity is such an abtruse science that few men can hope to attain eminence in the industry without the theoretical training of a university, still the young man at a lathe in a Schenectady shop is offered every opportunity for advancement. The electrical superintendent, who directs the work of the college men, is a self-made man. He began work at the lathe, twenty years ago, when we had no electrical engineering schools, and what he knows of electricity he picked up in the shops. The general manager, who is not an electrical expert, began his career as a clerk in a Connecticut grocery store, and later was an accountant in the electrical shops at Lynn, Massachusetts. He showed marked ability as a calculator, and he has developed at Schenectady a marvelous piece-price system. Not long ago, a gray-haired Yankee called at the shops to see the boy who had once been his grocery clerk.

"George," he asked, amazed, as he gazed at the hundred-odd buildings stretching far away toward the peaceful hills of Rotterdam, "do you mean to say you have charge of all these?"

It is in the testing department that the students begin their shop-work. On the floor of one of the big buildings is a maze of electrical machines of various sizes and forms. Their manufacture is completed, but they must stand the most rigorous tests before being shipped away. A special high-potential current enters the building from the power house, and generators, motors, and transformers, of from five to ten thousand horse-power, are subjected to voltages of double their normal capacity. All about the building are little switchboards, some of them placarded, "Hands off, Forty Thousand Volts." One day one of the students, while experimenting with a current of the intense voltage of one hundred and fifty thousand, was overcome by the electrically-generated ozone, but a little pure air restored him to consciousness. In the testing department, the young engineers become familiar with the completed product of the shops; later, they take up the study of construction, taking courses in other departments.

Power becomes a word of new meaning when the student begins his investigations in the central station, whose four great chimneys may be seen from all the country hill-sides. Every day two hundred and fifty tons of coal are brought from the mines of Pennsylvania to the shop's crushers, whence the fuel is carried by an endless chain of buckets to the roof of the boiler room. Automatically the fuel is fed to a score of furnaces, and by another system of buckets the ashes are automatically taken away. No stokers of flesh and blood are needed, for machines do the work of men. The engine room pulsates with energy. Here great generators, directly connected with the shafts of powerful steam engines, produce electric currents of the combined strength of six thousand horse-power. While all but three-hundredths of the engine-energy is converted into electricity, nearly nine-tenths of the energy of the coal is lost, and here every young engineer faces one of the great problems of industry. How can all the latent energy of the coal be directly converted into electricity? An ambitious student would give his life's work for this knowledge.

From waterfalls on the Hudson, miles away, thin copper conductors bring fifteen hundred horse-power of electric energy to the power house. So cheap is this power that, in time, it will do all the work of the shops. Just now, at Spiers' Falls, a dam, fifteen hundred feet long and eighty feet high, is being built across the Hudson, and here generators connected with turbine shafts will develop twenty thousand horse-power. The power from the distant river-station reaches Schenectady as a deadly ten-thousand-volt alternating current; and, before it can be used in the shops, it must be "stepped-down" in transformers to two hundred and fifty volts, and converted in rotary machines to a direct current. The seventy-five hundred horse-power electric energy thus obtained from the mines of Pennsylvania and the waterfalls of the Adirondack foot-hills is gathered, on a great switch-board, in a huge copper conductor, ten inches wide and an inch thick—well-named the *bus-bar*. The mighty energy flowing invisibly through this copper plank operates five thousand machines—cranes, trucks, lifts, tools—distributed throughout the hundred-odd buildings, and does the work of hundreds of thousands of men, but a man can rest his hand against it without feeling the slightest tingling.

Going from shop to shop, the young engineer becomes familiar with the marvels of American labor-saving machinery, and, if his inventive talent is keen, he finds opportunity to further increase the efficiency of these machines. In the new foundry, the largest gray-iron foundry in the country, the student finds that the making of twenty-ton castings calls for little manual labor. Imagine a steel-framed structure as long as the combined height of two of New York's tallest "sky-scrapers"—a building that would easily house the world's greatest steamship—and containing nearly three miles of railway track! And yet, less than nine months after the builders put spade to the ground, the first metal was poured. A dozen electric cranes whir under the roof, carrying about the foundry great ladles, each filled with fifteen tons of molten iron. Eight hundred men are at work there, and four score electric motors are at their service.

Machine tools—the wonder-workers of American industry—are met with everywhere. Nowhere else in the world can there be found such a varied collection of these steel automatons. Just now the largest machine tool in the world—a huge boring and turning mill—is building, in the new machine shop, a structure larger, even, than the great foundry. Several years ago a twenty-foot turning mill was installed, and it was thought that this would meet all future requirements; but, so rapid is the progress of electrical engineering, the new mill will have a working swing of sixty-five feet. Its brick foundation extends twenty feet into the earth. The increase in the size of electrical machines has exceeded the wildest dreams of the inventors of ten years ago. For example, the new generators in the power station of the New York elevated railway are forty-two feet high. Each weighs nearly a million pounds, and the revolving part, thirty feet in diameter, weighs as much as two railway locomotives, and revolves at a speed several times as rapid as that of the Empire State Express.

All the knowledge of the varied processes in the manufacture of electric apparatus—the insulating of wire one three-hundredth of an inch thick, and the automatic manufacture of cables coated with rubber and lead; the building up of armatures and field magnets, of generators, motors, and transformers; the constructing of electric locomotives for mining, mountain climbing, urban traffic, and trunk-line hauling; the fashioning of switches, switchboards, controllers, and meters, of arc and incandescent lamps, and searchlights whose gleam is visible ninety miles away—all the acquaintance with methods of constructing these, which the young student must have before he can hope

* From Success.

to take up engineering problems, is gained here in the home of the electric industry.

These young engineers, whether they take positions in the Schenectady shops or go to distant lands to girdle the earth with electric currents, will have one great field of work to attract their best efforts. This will be the utilization of nature's waste forces, and the carrying of the captive energy of wilderness waterfalls to far-away centers of industrial activity. Young Schenectady engineers are now in India harnessing the falls of the sacred Cavery, and transmitting, a hundred miles through the wilds, an energy of four thousand horse-power, to operate the mining machinery of the Kolar Gold Fields. They had to string the wires out of the reach of the wild elephants, put the posts in iron sockets to prevent the ants eating the wood, and place guards on the cross-trees to keep off the wild-cats. In California, a pole line carrying the energy of the waterfalls of the Sierra Nevadas to the city of Oakland, one hundred and eighty-nine miles away, has recently been completed. It is the longest in the world.

When the writer was in Schenectady, the locomotive works had just completed the most powerful railway engine in the world, while in the electric shops the construction had been begun of the most powerful electric generators. These are ten-thousand-horse-power machines for Niagara. The revolving fields will be attached to the tops of shafts extending one hundred and sixty feet into the rocks to the turbines. So the struggle between steam and electricity goes on. The Schenectady engineers believe that the most beautiful of machines—the steam locomotive—has had its day. They are ready now to haul all of the New York Central Railroad's trains by electricity, and guarantee that the cost of operation will decrease.

Among the American "captains of industry" who met Prince Henry in New York city, Dr. Robert H. Thurston, of Cornell University, was selected as the representative of engineering education. He may be said to be the father of technical education in America. This is his advice to America's future engineers:

"No young man should attempt to enter the profession of electrical engineering because it seems to him the current fad. To succeed, he must have natural talent for construction, natural ability in the fields of mathematical and physical science, and that vigor, pluck, endurance and good sense without which no man can succeed in any profession, old or new. He must have a practical as well as a theoretical imaginative side; he will need a good general education, and a very complete and specialized professional training, including the arts as well as the sciences of his department. Above all else, he must be a strong man, an honest man, a gentleman, if he would attain the highest success, gaining a reputation as a gentleman and scholar, as an expert and man of honor, as well as securing a competence. A good mechanic's hand, a fine scholar's head, a soul above trickery, and a character that can bear the scrutiny of all men, reinforced by a good common school education, up to and including a strong high-school course, and a real engineer's novitiate in the professional school, in the office, and in the workshop, furnish the highest possible guarantee of a successful business life that can be found to-day in the world."

THE COHERER.

HOW TO MAKE A MODERN COHERER AND A BRIEF REVIEW OF ITS HISTORY AND THEORY.

By WILLIAM A. DEL MAR, A.E.G.I.

THE popular impression that electricity having gotten over its infancy has no more surprises in store for humanity, was rudely dispelled when on December 12, 1901, Marconi succeeded in obtaining wireless signals over the Atlantic Ocean. Since then the public eye has been awakened to the possibilities of the system and lively interest is being taken in the work of the famous Italian inventor and his many rivals. The manifest faults and imperfections of the art in its present stage have acted as incentives to scores of experimenters who see a brilliant future not only for wireless telegraphy, but also for telephony without wires.

The apparatus most peculiar to the so-called "Hertzian wave" system of telegraphy is undoubtedly the coherer, as it is this simple device which enables the influence of the transmitting instrument to be detected at a distance.

As early as 1850 it was discovered by Guitard, that when dusty air was electrified from a point, the particles of dust tended to unite into strings. A similar phenomenon was observed in 1879 by Raleigh while experimenting with two jets of water. These jets issued from neighboring orifices and were arranged so as to rebound after colliding. When the two jets were respectively connected to the terminals of a single cell battery, they united into a single stream. The significance of this experiment will be explained later.

In 1879 Prof. D. E. Hughes, the inventor of the microphone and type-printing telegraph, found that metallic powders could be transformed from being very bad conductors to being very good ones by making electric sparks near them. He demonstrated this in 1879 to W. H. Preece, W. Crookes, W. Roberts-Austen, W. G. Adams, and W. Grove, and in 1880 to G. Gabriel Stokes, Huxley and Spottiswoode. He did not publish this until 1899 (see Electrician, London, May 5, 1899), and that only at the suggestion of J. J. Fahie, who had heard Sir William Crookes speak of the experiments. Six years after Hughes' discovery, and fourteen years before he published it, this property of metallic flings was independently discovered by Prof. Calzecchi Onesti, of Fermo, Italy (Nuovo Cimento, Series 3, vol. xvii., 1885). More exhaustive experiments were carried out in 1895 by Prof. Branly, of Paris. O. Lodge, who discovered that the property of increasing in conductivity under electric influence was common to all imperfect contacts, believed the increase of conductivity to be due to cohesion or welding just as in Raleigh's experiment with the jets of water. R. Appleyard confirmed this view by experiments with a liquid coherer. This consisted of two globules of mercury, touching one another, but kept intact by a thin film of grease. On connecting these globules to the terminals of a battery they coalesced into one. If two surfaces differ in potential by one volt and are separated by the thinnest film known (10^{-7} cm.) they are attracted with a force of over six hundred pounds per square inch. As the approximate contact between the charged globules is between points, the attraction is yet greater than this. Thus electrostatic attraction probably explains the experiments of Raleigh and Appleyard, but it does not explain all the phenomena of the coherer. In 1900 Prof. J. C. Bose, of Bombay, published the results of some experiments which could not be reconciled with Lodge's coherer theory. With a "coherer" of arsenic, the resistance *increased* under powerful electrical oscillations, but decreased under feeble stimulus. With oscillations of medium power, the arsenic "coherer" did not respond at all. In an osmium "coherer," the powerful radiations *decreased* the resistance, while it was *increased* by the feeble ones. As with the arsenic "coherer," there was a certain strength of radiation which produced no effect at all. Silver "coherers" at times acted like arsenic ones, and sometimes like those of osmium. The silver acting like arsenic and that acting like osmium were collected separately and made into the electrodes of a voltaic cell. They gave an electromotive force of one-eighth of a volt. There thus appeared to be two varieties of silver—allotropic modifications. This and other similar phenomena caused Prof. Bose to put forward the theory that metals are capable of conversion into allotropic forms under the influence of electrical oscillations and that these allotropic forms may have greater or less conductivity. This would be analogous to the action of luminous radiations on yellow phosphorus, which it converts into the red variety, or to the action of heat on mercuric iodide, in each of which cases the allotropic form differs in conductivity from the original substance. According to this theory, feeble radiation produces an allotropic form, while powerful radiation reverses the process. This effect is confined to the surface of substances.

It is safe to state that neither Lodge's nor Bose's theory perfectly explains the phenomena of the present forms of coherer, although both cohering and allotrope-generating influences are probably present. In the coherers made by Marconi, nickel and silver filings are used, and it was found advantageous to amalgamate the terminals with a little mercury. The mercury, no doubt, acts on the principle of coherence as with Appleyard's globules. It was found that the sensitiveness increased with the proportion of silver filings, and in order to preserve the sensitiveness it was found necessary to exhaust the air from the coherer. Under the action of feeble radiations, fresh silver filings from a silver rod decrease in resistance owing to the formation of a skin of a better conducting allotropic variety. This also, probably, is part of the action of the Marconi coherer.

We now go to the description of a sensitive modern coherer, embodying most of Marconi's improvements.

First select a piece of glass tubing of one-tenth inch bore and two and a half inches long, free from flaws; fuse onto it, about three-eighths of an inch from one end, another tube of about half its diameter and three inches long, and turn down a brass rod, three-quarters of an inch long to fit *loosely* into the larger tube. Then make a saw slit, one-eighth inch deep, across the diameter of the rod at each end, and file down the sides near the slits, as shown in Fig. 1. With a small file make a trough, big enough for an ordinary pin or needle to lie in, along the surface of the cylinder from end to end. This is to form an air passage between the brass rod and the interior of the glass tube. The brass work is completed by sawing the cylinder in half along the path indicated by the dotted line of Fig. 1, and filing the newly-cut surfaces smooth and level. Now select two pieces of fairly thick platinum wire, one inch long, and pinch an end of one in each of the saw slits. Suspend the brass plugs by their platinum wires in a silver plating bath and leave them there until they fit *tightly* into the glass tube. They must be fitted when at the temperature of boiling water. This is done by having a vessel of boiling water near the plating bath, and at intervals of a few minutes taking out the plugs, dipping them a few seconds in the boiling water, and immediately fitting them into the glass tube. Care should be taken that no silver gets on the platinum wire within half an inch of the free end. When sufficient silver has been deposited, the flat end of each plug is amalgamated with a little mercury, care being taken that no drops adhere.

Soak a clean rough file for several hours in a strong solution of caustic soda or other powerful alkali, and then thoroughly wash and heat it in a clean place. While hot use it to file, first a clean piece of pure silver and then a piece of pure nickel. Remove all the fine dust by blowing and sifting, and mix the remainder in the proportion of silver one part and nickel nine parts, taking care that they touch nothing soiled or greasy. When this is done, place one of the plugs with its platinum wire in the tube so that its amalgamated face is at the center of the tube. In order to allow for contraction afterward, the platinum wire is left rather loose in the tube, so that not over a quarter inch projects at the end. The plug is prevented from moving back by inserting just behind

Fig 1.

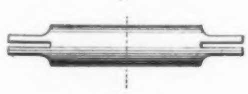
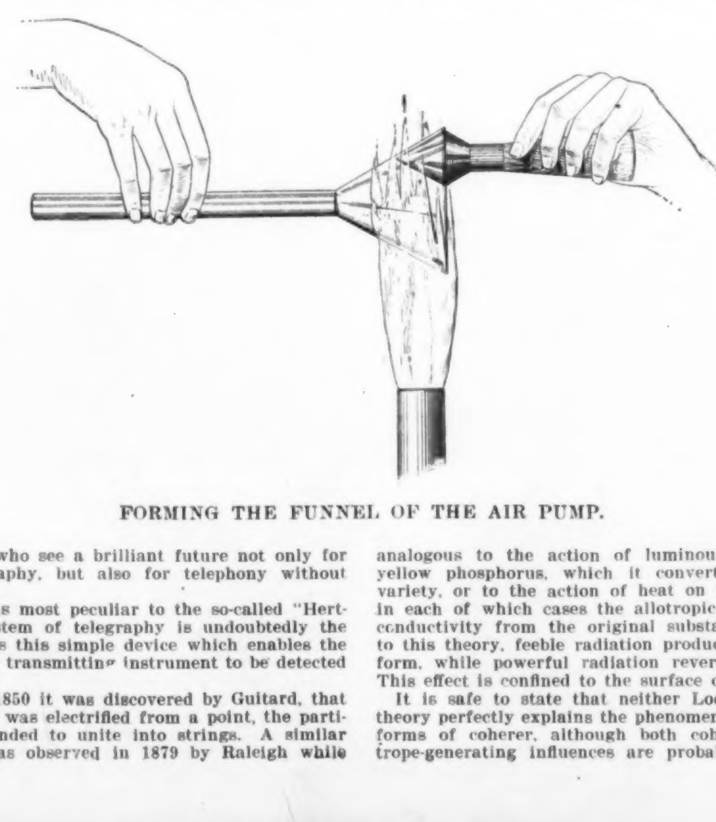


Fig 2.

THE COHERER.

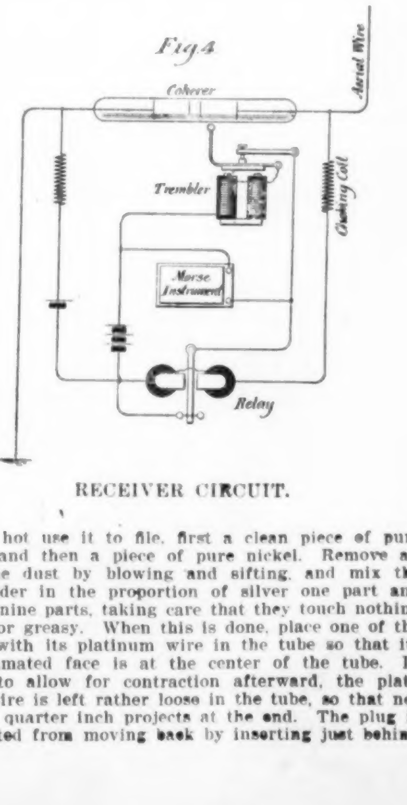
Fig 3.

MERCURIAL AIR PUMP.



FORMING THE FUNNEL OF THE AIR PUMP.

Fig 4



RECEIVER CIRCUIT.

it some thick paste of plaster of Paris and liquid glass, for about one-third of an inch. When this is thoroughly dry and hard, the tube is gently warmed to expel the last trace of moisture, and the end fused as rapidly as possible around the platinum wire with the aid of a blowpipe flame. Put the filings in the tube until when it is vertical they form a compact mass 1 mm. high. Then push in the other plug until its amalgamated face is 1½ mm. from the first—the filings being thus very loosely packed—and back with plaster as before. When putting the plaster in each end a fine needle should be placed in it and sticking in the file troughs at the sides of the plugs, so that when the plaster is hard and the needles withdrawn, there is a continuous air passage through the plugs and their plaster backs. Now seal the end of the tube around the platinum wire as at the other end. The tube is now ready to be exhausted of its air. Fuse the branch tube on to the exhaust tube of a mercury pump, and when as perfect a vacuum as possible has been obtained, seal off the branch by means of a blowpipe.

To complete the coherer it has only to be mounted with suitable terminals, but care should be taken in mounting that the air passage is placed at the top. A good way to mount it is in an ebonite block, 3 inches x 1 inch x ½ inch, out of which a trough has been dug to fit the coherer tube, and which has a couple of binding screws as terminals. The whole should then be incased in a box of sheet brass or copper having only a couple of small apertures for connecting wires. This is to protect it from the influence of local sparks.

A short description of how to make a mercury pump is appended.

Hold one end of a piece of thick glass tubing of about one eighth inch bore and forty-four inches long, in a big blowpipe flame and continuously rotate it to assure even heating. When the tip is at a bright red heat rotate the tube rapidly between the thumb and forefinger and open it into a funnel as shown in the cut. When this is done stop up the end opposite the funnel and use a fine tongue of the blowpipe flame to heat a spot seven inches from the top of the funnel. When a small spot is red hot blow in at the funnel end and burst a hole in the glass at that point. A piece of the same kind of glass, four inches long, is heated to a bright red heat at one end and laid on the equally hot edges of the newly-made aperture. If the joint is not complete, blow in the funnel end and play round the joint with the blowpipe flame. When the arm is securely fused on, heat it all around at about two inches from the free end and draw it out until its diameter is about the same as that of the coherer arm. The tube is held, funnel up on any sort of stand so that the bottom is about six inches above the floor. Securely fixed on the bottom is a thick rubber tube joining it to a similar glass tube five inches long. About an inch of the rubber pipe is between the two glass ones so that a clamp can be put on to close the passage. The small tube at the bottom is dipped an inch below the surface of mercury in a deep trough. The pump is then complete. In order to exhaust the air from the coherer, the edges of the pump arm and coherer arm are heated to a red heat and pressed together. The edges must, of course, have been broken off straight. This is done by scratching the glass with a file and breaking sharply at the scratch. Mercury is now poured down the funnel. As it passes the arm of the pump it carries the air down in bubbles. The mercury is baled out of the deep trough and poured through the funnel over and over again. Care must be taken to keep some mercury always in the funnel. The flow of mercury can be regulated or stopped by pinching the clamp on the rubber tube. When no air is visible in the lower mercury column, seal off the coherer arm not far from the body of the coherer. This is done by quickly heating the arm at a red heat all around at the selected point, drawing it out quickly and twisting it off.

In all its telegraphic applications, the coherer must be supplied with a tapper or decoherer to restore the filings to their original non-conducting state. This may be a small trembling bell with its gong removed and the coherer put in its place. This trembler should be put in the brass case with the coherer so that the hammer hits the glass tube. In order to prevent the spark of the trembler from affecting the coherer, the points between which the sparks occur are shunted by a high resistance. Not more than one Leclanche or Daniell cell should be used with this coherer. The circuit consists of the coherer, the cell, a regular telegraphic polarized relay and two choking coils, all in series—one end of the coherer being earthed and the other connected to the aerial wire. The choking coils are placed adjacent to the coherer, one at each terminal.

EXPERIMENTS IN THE USE OF OXYGEN IN CASES OF CARBON MONOXIDE POISONING.

CLAUDE BERNARD has demonstrated that an animal poisoned by the vapor of carbon rapidly loses the poisonous carbon monoxide that has been absorbed by the blood, if the animal is again made to breathe pure air. His researches were published in 1875, in a book entitled "Lessons Upon Anæsthetics and Asphyxia."

I shall soon have occasion, says Prof. Nestor Grehant, in La Nature, to make known this work by one of the greatest physiologists of modern times, who has proved that the combination of hæmoglobine with carbon monoxide is easily dissociated. I esteem it my duty in the meanwhile to give a summary of my most recent experiments in a subject which is far from being exhausted, the results of which point to the treatment, by oxygen, as the proper one for the frequent poisoning caused by carbon monoxide. In the prosecution of this toxicological study, it has always appeared to me to be indispensable to extract the gases from the blood, and, in the experiments that I am going to describe, I have had to effect such extraction six times in a single laboratory operation, making use for this purpose of six flasks such as may be seen in Fig. 1, No. 2. In each of the flasks, which is closed by a rubber stopper and provided with a cock and rubber tube surrounded by a small cylinder full of water (forming a water seal), a vacuum is first formed by means of a Golaz air pump. Fig. 1, No. 1 represents my mercury pump, which has a cock surrounded by a metal cylinder filled with water. This pump I have employed for more than thirty years. It is an excellent apparatus for completing the vacuum in each receptacle. In the figure may be seen the operation of injecting with a syringe some blood taken from an artery.

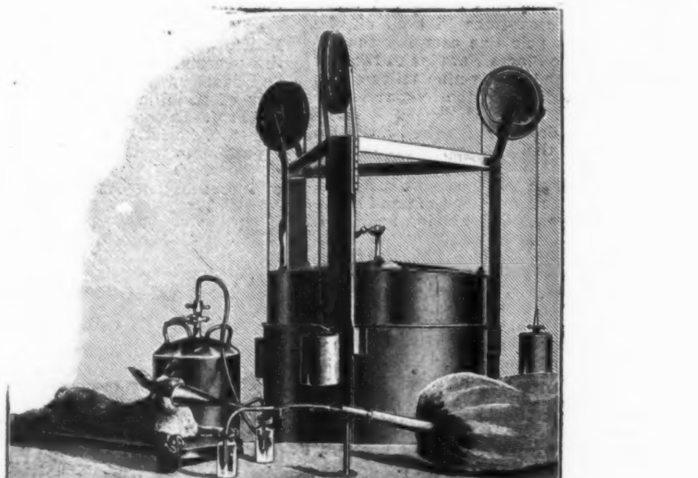


FIG. 2.—ARRANGEMENT EMPLOYED FOR MAKING AN ANIMAL RESPIRE A ONE PER CENT MIXTURE OF AIR AND CARBON MONOXIDE AND PURE OXYGEN SUCCESSIVELY.

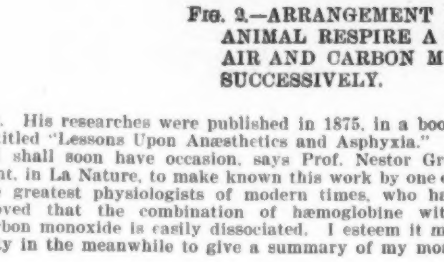


FIG. 3.

A mixture of 99 liters of air and 1 liter of pure carbon monoxide having been formed in a Saint-Martin gasometer (Fig. 2), a rabbit or dog is made to inhale it for 15 minutes by means of hydraulic valves serving for inspiration and expiration. Previous to this a carotid or femoral artery has been laid bare. Fifteen minutes after the beginning of the poisoning, which would be mortal in 20 minutes with a carnivorous animal, a first extraction of 15 cubic centimeters of blood is made, from which I am able to determine the volume of carbon monoxide absorbed by 100 cubic centimeters of blood. These extractions of blood are repeated every twenty minutes, and the volume of toxic gas contained in the hæmoglobine is seen to diminish when the dog inhales pure air after partial poisoning.

Fig. 2 shows the arrangement that I employed for making the animal respire oxygen at the ordinary pressure after a poisoning of fifteen minutes' duration. The gasometer is closed by turning the valves, and a rubber bag full of oxygen (the supply of which is obtained from a compressed oxygen reservoir) is opened.

Fig. 3 represents the two curves, one of which was obtained by causing the animal to respire oxygen after partial poisoning, and the other by making it respire pure air after a similar poisoning. It will be seen that the dissociation of the oxycarbonated hæmoglobine is much more rapid in oxygen, the curve descending abruptly and closely approaching the line of the abscissæ, while if the animal respires pure air, the curve descends more slowly and reaches the line of abscissæ much later, and at the end of a period that my experiments will permit me to measure.

The conclusion drawn from this study obliges me to give the following advice: In a case of poisoning by carbon monoxide, renew the air as completely as possible around the patient in the first place. Then send at once to a druggist for a cylinder of oxygen and make the patient respire the gas, taking care to keep him well supplied for more than an hour. I advise druggists always to have a large stock of oxygen on hand, so as to render it possible successfully to cope with a poison that has so often proved mortal.

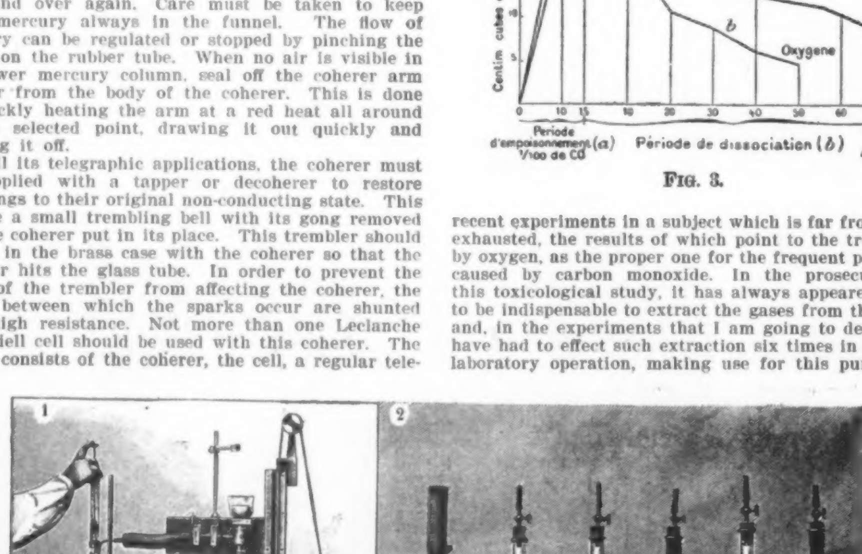


FIG. 1.—1. MERCURY PUMP FOR PRODUCING A VACUUM. 2. SIX FLASKS EXHAUSTED OF AIR.

COMMERCIAL VALUE OF HUMAN LIFE.

IN a recent number of Popular Science Monthly, Marshall O. Leighton undertakes the grewsome task of figuring out the value of a man's life in dollars and cents.

There are two radically distinct measures of human life, Mr. Leighton tells us. One is purely humanitarian and considers only the divinity of man. Under such an estimate the life of a human being would be priceless. The other estimate seeks to eliminate all sentimental considerations and deals with the individual on the basis of his use to the community as a productive agent, like a house or locomotive.

Rochard gives it as his opinion that the value of human life is determined by what the individual has cost his family, the community or state, for his living, development and education. It is the loan each individual has made from the social capital in order to reach the age when he can restore it by his labor. But such a statement would hardly be accepted by most men. Under such a value the resource vested in an individual grows from birth not with his increasing powers of production and the greater certainty of his attaining the age of self-support and becoming useful, but by reason of the fact that his maintenance is costing more and more.

Many suits for damages in courts of law for the wrongful deaths of persons constitute the commonest, most fruitful, and almost the only trustworthy references available in which life values are dealt with. It has been necessary for judicial authority to consider the

question to a minute degree. Pecuniary loss is made the basis of damages and exemplary or punitive damages are rarely granted.

From 147 cases examined by Mr. Leighton, so selected that no unusual circumstances or condition to render them non-representative of the great majority appeared, he finds that the pecuniary value of human life is subject to the same economic laws as are applied to the more vulgar commodities. This pecuniary value of a life to its relative represents its pecuniary value to society. Damages given for a wrongful death are such that they can be represented by an average in different age groups with only narrow limits of probable error. The relation of these age group values, one to the other, is supported by common observation and statistical reasoning.

MANNERS AND CUSTOMS OF THE PEOPLE OF SOUTHERN BORNEO.*

By H. M. HILLER.

ABOUT three years ago I had the pleasure of addressing this society upon the manners and customs of the natives of Sarawak, a country from which we had but lately returned. Since then we have again visited Borneo, and extended the field of our investigation, so that from Labuan on the north and west, all the way around to the mouth of the Balungan River on the east, we have touched at most of the important places, entered the mouth of nearly every river, and ascended the larger rivers as far as was possible under the existing conditions.

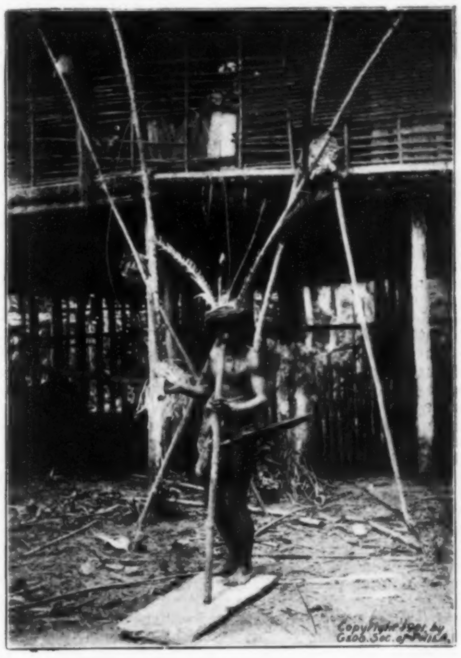
Our party divided at Singapore in the early part of the year 1897. Dr. Furness returned to Sarawak, and Mr. Harrison and I proceeded to Dutch West Borneo. Six months later we again met. Dr. Furness had by that time explored the headwaters of the Baram and Tinjar rivers. Mr. Harrison and I had ascended the Kapaus River to a point about a day's journey beyond Putus Sibau (the last Dutch outpost), a distance of over five hundred miles from the seacoast; we had also ascended the Sibau, a tributary of the Kapaus, to its source, crossed the intervening watershed (the "Tohen Batu"), and descended the Balleh and its tributaries, eventually reaching the sea at the mouth of the Rejang River. In October, 1897, Mr. Harrison and I proceeded to Dutch East Borneo, ascending the Kotei River to the village of Ana, a distance of about three hundred miles. We had expected to ascend the Kotei River as far as it was navigable for canoes, to cross the Tohen farther to the eastward, and again reach the sea by way of the Balleh and Rejang rivers. In this latter enterprise we were disappointed, because the Dutch governor would not give his consent for us to proceed beyond Ana. It was during these attempts to explore the central highlands, and the delays caused by the Dutch officials, that we were able to collect many of the ethnographical and natural history specimens now displayed at the Museum of the University of Pennsylvania, and that Mr. Harrison was enabled to make this unusual collection of photographs, which I shall show you to-night.

In order that these photographs may be the more readily understood, let me refresh your memory as to the geographical, political and social conditions that exist in Borneo at the present time. Borneo is the fifth largest island in the world, and has an area of about 286,000 square miles. It is jungle-clad from its marshy coast to its central mountain chain. In the lowland swamps the mangroves plant their stilt-like roots in the mud and the nipa palms fringe the tidal waters. Between this marshy coast and the hills stretch the level forest lands, where the great, buttressed tapang and banyan trees tower above the palms and ferns, and the creepers knit their boughs into an inextricable tangle. In the hill country the forests are more open and there are game trails leading across the ridges that separate one watercourse from another; but in the lowlands even these game trails are seldom seen, and the streams are the only practicable routes of travel.

Nearly all these streams take their source in the central mountain chain, and where joined by other brooks they soon become torrents that dash down the rapids and over the rocks with incessant roar. Their waters, clear and cold in the highlands, are soiled by the muddy banks of the lowlands, and the incoming tide lessens the force of their currents. In the uplands the trees overarch the streams, creepers festoon from bank to bank, and orchids droop over the waters; but in the lowlands there is no such beauty of scenery; the sun beats down with pitiless fury upon the broad reaches of the rivers, an unbroken silence reigns throughout the heat of the day, and the crocodiles, sunning themselves upon the muddy banks, seem the only evidences of life. But hidden away among the undergrowth there are myriads of insects, reptiles, and four-footed animals; birds and monkeys inhabit the trees, and at early morning and again before sunset all this silent lowland bursts into movement and song.

Each of these streams, and the region drained thereby, becomes a country, or "negri," and beyond the point where the waters divide, to fall into this or that river-basin, the native will not travel without first performing peculiar ceremonies; when once he has overstepped this imaginary border line he feels as if he had left his home and fatherland far behind; he is a stranger in a strange land; he fears for imaginary dangers, and becomes homesick, just as other people whose skins are not so dark. When we crossed the central watershed we saw many of these customs; for among our following were men of various tribes, and each had its own peculiar rite to perform.

A TUNJUNG GIRL, KOTEI RIVER.



A TUNJUNG DANCING, KOTEI RIVER.

Before drinking of the waters in the new country, the Kyans took a knife in their teeth, immersed themselves in the stream, and muttered their petitions to the spirits. The Bukit went down into the first tiny brook, divested himself of all clothing, took an earring from his ear, threw it into the water and then offered the following prayer to the water-nymphs: "O spirit of the waters, I make you this offering to show you that your children do not forget you; protect me, I pray you, keep me from harm in the country I am about to traverse, keep me from sickness, from poison and death in the land of your waters; bring me back in safety to my own country!" He had wound a chaplet of sweet-scented leaves about his brow; he was naked, and as he stooped there in the running waters of the stream, lifting the first handful of water to his lips, it was hard to realize that it was only Laioh, the Bukit, and not some faun.

PUNANS FROM THE BUNGAN RIVER, A TRIBUTARY OF THE KAPAUS.

A KANTU WOMAN WEAVING A BLANKET, KAPAUS RIVER.

The night we reached the summit of this mountain chain and came to the point where the waters of the Kapaus separate from the waters of the Balleh, the whole party joined in the performance of the following ceremony. They had brought some chickens' eggs from their home (almost a fortnight had been spent in reaching this point); these together with some rice were placed in a basket and the chief then passed it around to each one of us, that we might lay our hands upon the eggs and pass our fingers through the rice. The eggs were then placed in forked sticks by the side of the trail, and Tegang, the chief, as spokesman, thus addressed the "hantu-tohen," the spirits of the highland: "We make you presents of rice and eggs, that you in turn may protect us in the land we are about to enter; let no evil spirits follow us, let no one poison or kill us, give us good omen-birds, and a safe return to our own people." As the one small lamp burned a hole in the inky blackness of the night, the wreaths of mist drifted across the ridge like disembodied spirits, and it needed but an ounce of credulity to make anyone believe that the "hantu-tohen" were prowling around in the darkness.

The different tribes living in a river basin are usually at peace with each other, but are nearly always at enmity with the tribes living across the nearest watershed; and this may to some extent explain their fears and the performance of these peculiar rites whenever they leave their own "waters" to enter the stranger land.

Until within recent years the natives of Borneo were able to carry on their old-time customs of slavery, of war and of head-hunting; and to-day, despite the best endeavors of the different government officials, these evils still prevail to some extent.

At present Borneo is largely governed by white rule. Sarawak is more familiar to the English reader than any other portion, though it comprises but one-fifth of the area of the island. The British North Borneo Company has of late years assumed control of the extreme northern end of the island. The Sultanate of Brunei is still semi-independent, and consists of a small area wedged in between North Borneo and Sarawak. The largest portion of the island, however (about 200,000 square miles), comprising all the lands situate south and east of the watershed, has been for several centuries under the control of the Dutch; yet despite the fact that white men have owned and governed Borneo for so long a period, it is far behind the other islands of the Malay Archipelago in density of population and development of resources. There are no coffee or sugar cane estates, no spice or tea gardens, and the fertile lands are scarcely broken by a permanent clearing; the trackless jungles are almost unknown, except to the monkeys and the birds inhabiting the branches overhead, or to the four-footed folk who hide among the bracken and the fern; and the "babas," or new jungle, reclaims the tentative farm lands, blots out the last-year's trail, and covers every trace of fire, of war, and of death with its all-obliterating carpet of green. Here and there a native cuts out a pathway to his field, and in a few years the "babas" has left no trace of either; consequently, he travels by the waterways, builds his house and clears his fields near by a stream, so that he can obtain easy access to them by means of boats. This has made the

* Abstract of a lecture delivered before the Geographical Society of Philadelphia and published in the Bulletin of the Society.

natives efficient boatbuilders, and those who live in the hills, where the rapids and currents are dangerous, are among the most skillful canoeists in the world.

The main task of their life is the tillage of the small plots of ground cleared of jungle with persistent toil, and set apart for the cultivation of rice, which is their staple food. By way of luxuries, at times they vary their bill of fare with fish, salt, vegetables in the shape of tubers, succulent roots, and green fern fronds, and, on rare occasions, meat. Owing to their superstitions they are debarred from eating many kinds of meat; even the pigs and fowls which they keep about their houses are eaten only on great occasions, as when children are named or when "taboos" are raised.

Salt is obtained from the trader in the bazaar, fruits grow wild in the jungle, and fish are usually to be had for the casting of a net. Ordinarily the harvests are good, yielding a sufficient supply of rice, and nowadays, even though the harvests should fail, there is less danger of a famine, because they can purchase food from the trader and pay for it in jungle produce, such as damar-gum, gutta-percha and rattan.

It is the search for these latter products that takes the natives to the hills, or even over the borderland into the stranger country, and accounts for the feuds that have existed for centuries. For some doughty but untried warrior, in order to win his spurs, either by bravery or treachery, would take these opportunities to secure the coveted token of his prowess; and many a long-standing quarrel has begun and ended on the watershed.

Head-hunting was at one time a very popular pastime; the head of an enemy entered so largely into the customs of the natives, their superstitions and their religion, that in order to prevent a great number of calamities, and, in many instances, to secure happiness, a head was essential. Hence, in former years, at the conclusion of a successful harvest, when the granaries were filled and the birds had been consulted and found propitious, they organized the "Pantang-Naioh," or regular head-hunting expedition. But the various governments have strenuously opposed head-hunting, and to-day a head is seldom taken, save when some tribe crosses the border on a marauding foray; then a retaliatory expedition is sanctioned by the powers and a goodly crop of the ghastly plunder results. Although this head-taking desire burns as fiercely as of old, yet the penalties are too often imposed to make it popular, and when a gutta-percha hunter meets a rival on the "tohen" he usually passes the time of day and departs in peace.

While in the upper Kapaus valley I learned how the natives now play Hamlet without the ghost, and find a substitute for the "Pantang-Naioh." In this instance, as in many another case, they hoodwink the spirits by the following ruse:

We were ascending the Mendalam River, in company with Tegang—a young Kyan chief—and some of his slaves, when we met some Malay traders, who informed us that they had heard the sound of gongs being beaten, which is the signal to inform the members of a tribe that some calamity, such as a fire or a death, has occurred. Consequently, the slaves were urged to redoubled exertions and we sped through the waters. Fortunately for our friend, Tegang, we soon met some natives who informed us that the cause of the gongs being beaten was the death of a child, the daughter of Lodang, a chieftain who lived farther up the river. The father of the child went into mourning, and, according to custom, no beads or other ornaments were worn; the father wore a bark loin cloth, the other relatives put on their oldest garments, and the house was "pantang," or tabooed. In the meantime the child's spirit had gone to Bukit Tepelong, to wait there outside Julang Telang, or paradise, until Lodang should bring a fresh head into the house.

A few days later Lodang came down to our camp, his face showing unmistakable signs of sorrow; he wore a single garment—the loin cloth of bark; his sword was wrapped in palm leaves, and he announced that he was on his way to the upper Mandai River to get a head in order to raise the "pantang." I could not understand how he dared incur the government's displeasure, but upon his return he proudly showed me an old and well-dried head which he had *purchased* of the Mandais, and a lower jaw, obtained from my old friend, Kumbang, the Kantu chieftain. There was feasting and dancing at Lodang's a few days later, and his child fittingly and appropriately entered Júlang Telang, while the "Hantus" never dreamed that they had been imposed upon.

From the foregoing remarks you may be led to believe that the men do nothing but cultivate the fields or go on the warpath, but such is not the case; they are skillful at working iron; they make boats, mats and baskets; they build houses and fashion their weapons. The women also have many duties to perform—they card, spin and dye cotton, from which they weave artistic blankets and other useful garments. Furthermore, there is a lighter side to their life than one would suppose; there are the feasts and the dances, especially after the harvests; they have the flute and a reed instrument, called the "kaludi," on which the youths play the music for the war dances or the softer strains of the serenade. They have rum, with which they are able to obtain a mild carouse; and last, but of prime importance, tobacco, used by all, from the toddling babe to the tottering old crone. Tobacco is to them the next important item after their food, and we always found it useful as a trading medium, even when salt would be refused. Children begin its use long before they shed their milk-teeth, and I never heard them complain of the injurious effects of the "cigarette habit."

The children were always a source of great interest to us; they have good manners, are very efficient and useful, even from their infancy, and I have seldom seen one who was impertinent or dishonest. They run errands and assist their elders, and early learn to take a man's part in life. In the boat, in the field, or in the duties performed about the house, they always do their share without complaint. On our various expeditions one or more boys usually accompanied us, and we invariably made them our intimate and trusted friends. They taught us their language, their songs and dances, how to set traps and cast the fish nets; to wrestle, to spin tops and to make their intricate figures of cat's-cradle. Their parents were always kind and affectionate toward them, and I have seen a mother put her babe to sleep with a lullaby, the words of which I could not understand, but the meaning of which was unmistakable; and the cradle would swing but a few moments before this time-honored soporific would have its effect.

Within the limits of this paper I can speak only in a general way of their many interesting customs. They live for the most part in community houses, where the roof of thatch or clapboards, perhaps a quarter of a mile in length, shelters an entire tribe, amounting in some instances to one or two thousand people. A partition of rough-hewn boards runs lengthwise down the center, separating the floor space into a front veranda, or street, and a compartment at the back, which is further subdivided by cross partitions to form the separate rooms for each family. The floors are also of boards or bamboos, and the houses are raised on posts or piles to afford protection from the dampness, from beasts of prey, and to render it a fortress in time of war. In some instances, palisades surround the house and outlying granaries, and an entrance is only to be gained through strongly-guarded gates. These are the so-called "long houses" of the more powerful tribes; on the other hand, such jungle nomads as the Punans build a tiny, miserable hut of leaves.

I have said that the chief object of their life was to secure a sufficient store of rice. Almost as important to most of the tribes is the consulting of omens. They watch and listen for the birds, to see or hear them on this side or that, in order to learn the warnings of the spirits, and thus they avert evil or secure happiness. Every act of life, every natural or unnatural phenomenon is under the control of the unknown spirits, and they send warnings to the natives by various messengers; chief among these are birds of various kinds; also spiders, snakes and lizards; the barking deer, the falling tree, are signals; and every expedition, be it of peace or war, is prefaced by ceremonies in which the omens are consulted. Each field that is cleared, each house that is built, requires that the omens be consulted for fear of offending the spirits that preside over the field and the home. The new-born child is ushered into life with mysterious ceremonies, the old man leaves it with appropriate rites, and this constant fear and vigilance adds a bitter drop to every cup they drink.

Yet the natives are not without their ideas of a "hereafter." They, too, have a River Styx, a purgatory, or place of waiting, and a final "haven of rest," where those who have gone before await the coming of their kindred and friends. In every region there is one hill or mountain, conspicuous by reason of its isolation, its height or its peculiar conformity, whereon the departing spirit rests before taking its final flight to the sky, or the true and final resting-place of all Bornean souls. This detention may be for various reasons, but in the old days a disembodied spirit often waited on the mountain peak until its family or its friends could take a head from the enemy in order that it might have a slave to fittingly accompany it when it met its "fathers."

The following note is quoted from my journal to give you an idea of the popular belief in regard to the departing spirits:

"In the valley of the Barito River, half way up the Teweh tributary, stands the 'Mountain of Moss,' Gunong Lumut. Here, after the body has ceased to be the home of the soul, reside the souls of the Tunjungs and many other tribes living in the Mahakkam and Barito river regions. When the messenger of death, Taman Rikung, comes to claim the soul, or Kalalungan, and conduct it to Taman Kuring, who dwells on Gunong Lumut, the friends of the deceased put his body in a coffin hollowed from a tree trunk, close it with a lid, seal it with damar gum, and place it in the living room of the house, where it may remain for two or three years until a good harvest is secured. Then a great festival is held, the friends are called together, and feasting and drinking ensue for three days and nights. The body is then consigned to the ground, and thus peacefully the soul is freed from Taman Kuring and goes to the abode of perfect peace, Teluan Tankeh Langit, which is in the sky. When Taman Rikung leads the soul toward Gunong Lumut, he comes at length to the Rayah River (the River Styx of all the Bornean tribes), over which is placed the usual log—Batang Katu—but the log has this peculiarity, it is not quite long enough to span the stream from bank to bank, and as the soul and its conductor reach the bank the log glides up to them, and the soul (of the deserving one) steps on this log and is ferried across in safety to the opposite shore. If, however, the soul of a wicked person approaches, the discerning log suddenly slips away as he steps upon it, thus precipitating him into the waters where dwell the fiends, typified by a huge fish, called 'Unkong Sulung Kowang,' which devours him, and he dies a second and final death from which there is no resurrection. I asked one man what constituted a crime so heinous as to cause a soul to be cast to the devouring fish, and his prompt reply was, 'Any man who refused to get married'; nor could I get him to cite any other cause so wicked."

Whence came the people of Borneo has never been definitely determined. The various immigrations have left no enduring data by which the student of anthropology can ascertain to which of the many kindred people of the Malay Archipelago the several tribes belong. They have no written language, they carve no hieroglyphics on stone, and their speech changes with each locality, or each successive tribal movement; so that philology, also, can aid us but very little in our study of the origin of these people. No one of these tribes can be taken as a type; nor, on the other hand, can you find sufficient differences to justify the belief that there is one separate race among all this great number of tribes, although each bears a tribal name and boasts a tribal individuality.

I cannot here mention all the tribes, even by name; let me speak of a few with whom we are more or less familiar: The Bukits and Punans are jungle nomads, the least civilized and most timid of all the tribes, living in small leaf huts in the central hills, subsisting on jungle produce, and rarely, if ever, tilling the soil. The Kyans and Kenyahs live on the upper waters of the principal rivers, build good houses, travel far in search of jungle produce; they are strong in numbers, and are formidable in war. The Bahaus, the Pengs, the Long Wais, and a host of others belong to this same group, as do the Trings, who are said to be cannibals, and the Tamans, who are the metal workers for many of the other tribes. They all cultivate the hill varieties of rice, and when their crops fail can usually find sago and other foods in the jungle. The Tunjungs, the Bentians and kindred tribes living near the seacoast, have been subject to the Sultan of Kotei so many years that they lack the wealth, the spirit and the independence of the hill tribes. Their houses, boats and weapons, their customs and language all testify to their subjugation. We found the Tunjungs a tribe that had especially suffered from the suzerainty (and the taxation) of the Sultan, who, in return, had not been able to protect them from their enemies; and the contrast between all the tribes living under his jurisdiction and the more independent and warlike tribes of the hill country was very easily noted.

As a general rule, each tribe, or even a sub-tribe, may have its chief, or rajah, who calls the older men of the tribe to counsel with him, and his rulings are generally decisive. This office is more or less hereditary; consequently, they have class distinctions, and there is the ruling class, the freedman and the slave. The slaves, taken captive in the various raids and war expeditions, or the descendants of those previously so taken, do not suffer all the hardships that the word "slave" conveys to our mind. Among a savage people where the struggle for existence is hard, each man's labor is of great importance, and in Borneo a slave does not fall so far below the estate of his master as he would in a more civilized country. On account of the constant strife, the epidemics and an occasional famine, some of the tribes are gradually disappearing. We visited one house where, but a few weeks before our visit, an epidemic of smallpox had taken seventy-five out of a house of one hundred and fifty-five people, and on more than one occasion we have met the last man of his tribe. Such tribes as the Kyans seem to hold their own, and the Kantus and the Ibans are slowly increasing, but it would be idle to prophesy for the future.

PETROLEUM IN ALGERIA.*

Unfortunately for the industry of petroleum in this country, the nummulitic outcroppings are rare and not important. So, the principal engineers who have previously prepared reports respecting petroleum on the account of proprietors, have disregarded this stratum, which is not apparent to sight, and which in my opinion could in several places where work has been carried on be reached only at a minimum depth of 500 meters.

The success of enterprises has seemed to depend upon hazard. The projectors have appeared to be regardless of geology. Some have been favored by fortune, while others would do better to abandon the work commenced than to pursue it with no chance of success.

The petroliferous system of the department of Oran may be considered as formed of seven productive zones corresponding to seven anticlinal folds running from west-southwest to east-northeast in a direction nearly parallel to each other. These zones may be designated as follows:

To the North of Chelif.

First Zone—Sidi-Brahim; Renault.
Second Zone—Stidia; Ain-Zeft.
Third Zone—de Bel-Hacel.

To the South of Chelif.

Fourth Zone—de Blad-Teytonna.
Fifth Zone—Medjilla-Zemnora.
Sixth Zone—Kalaa-Sidi-Mohamed-ben Aonda.
Seventh Zone—Ain-Faress-Djebel-Menaoner.

In general the strata forming the base of the tertiary (the lower standstones of the Helvetian and the Cartennian, the schists and sandstones of the Eocene, nummulitic sandstones, limestones and sand) may be considered as capable of containing different horizons of petroleum, of which the lowest will be the richest. In the upper strata, only the oozing has so far been met with, sometimes, as at Ain-Zeft, pockets, in which the petroleum, devoid of light products, would demonstrate by its very nature its long passage from the deposit that is in reality productive.

The characteristics of petroleum may be considered as a reliable indication of the distance which separates the point of oozing from the productive layer. It follows that almost always the petroleums of the surface are heavier than those obtained at a depth. If a well is bored in a good place, in proportion as it advances this fact may very readily be noticed. In this respect the accompanying table relating to samples that have been collected in different places should be carefully studied. It will show among other things that in the lands which most resemble those that I have indicated as petroliferous, the density of the oil decreases, while in those which are even near the old and volcanic formations, in the Dahra, for instance, but far from the base of the tertiary, the petroleums present all the signs of a long journey.

According to the table, the petroleums proceeding from the upper layers, that is to say, those of the zones situated to the north of Cheliff (Macta, Mostaganen and Dahra), present the characteristic of heavy oils, tarry, pasty at the higher temperatures of Algeria.

It has often been objected that the nature of the petroleum found in the region of Dahra was not only suitable for industrial treatment, but indicated a deposit of slight extent.

This petroleum, of which I have collected several samples, is heavy, tarry, pasty at high temperatures. Such as has been collected at the surface, as well as at deep points, where oblique fissures, or even horizontal oozings have been reached, appears indeed, on

* From the French of M. Henri Neuberger. Summary of Report to the Petroleum Congress.

Source of the Oil	Geological Formation	Physical Characteristics. Density at +15°	Natural Condition	Color	Odor	Evaporation in one month at +15°	Point of Ebullition	Point of Solidification	Chemical Composition C %	H %	O %	N %	Light Oils and Loss	Industrial Grades Lamp Oils	Heavy Oils	Paraffine Oils	Mazout or Residue
Ain-Zeft	Helvetian	0.971	Pasty	Black	Slight	Slight	+162°	— 1.2°	78	7.1	14	0 9	3.50	13.50	32	29	22
Sidi-Brahim	Sahalian	1.016	"	Brownish black	"	"	+158°	— 1°	81	6	10.9	2.1	5.50	11	29.50	29	23
Bel-Hacel	"	0.989	"	" "	"	"	......	— 4.4°	....	......	......	....	......	......	......	......	......
Medjilla (surface)	Cartennian	0.835	Liquid	" green	Sulfurated	19%	+114°	—13.5°	83	9.50	7.50	Traces	6	50.50	15	2.50	26
" (42 m.)	"	0.795	Very liquid	" "	Not disagreeable	19	+ 94°	—16°	82	11	7	"	7	53	13	3	24
" (56 m.)	"	0.794	"	Greenish	"	34	+ 81°	— 17.4°	80.5	13	6.5	"	9.50	56.50	7.50	3	23.50
Messilla (surface)	"	0.842	Liquid	"	"	17.5	+110°	—11°	84.05	9.50	6	"	5.50	48	16	4	26.50
" (98 m.)	"	0.830	"	Black	Strong and eth.	21	+ 93°	—12°	82.50	12	5.50	"	5 50	54	12.50	4	24
Sidi Mohamed (surface)	Nummulitic	0.811	"	Brownish green	Not disagreeable	... ...	......	....	......	......	......	....	......	......	......	......	......

account of its consistency, to be difficult of exploiting by boring. Its slight fluidity is an obstacle to its gushing, and even to pumping.

But this oil ought to be considered as a surface petroleum, oxidized and deprived of the greater part of its light constituents, having, so to say, undergone a complete distillation on its journey. In fact, oxidation in petroleums proceeds from a contact more or less prolonged with the atmosphere, or with the oxygenized products which it may meet with below the surface. Such are the resinous or asphaltic products (petrolene $C_{20}H_{32}$ and asphaltine $C_{20}H_{32}O_3$). It must be admitted that the proportion of oxygen in petroleum increases to a certain extent in consequence of its exposure to the air. There is a corresponding loss in the proportion of hydrogen, and even of carbon. This property explains why mineral oil, after a greater or less exposure to the air, loses a part of its caloric power.

The phenomenon that has been mentioned, of which an example is seen in the Dahra, I have had occasion to study at Sloboda, in Galicia. In a petroleum of this deposit and a sample of tarry petroleum from the same source, but oozing from fissures far from its origin, which may be considered as a simple asphaltic transformation of the first sample, the following elements have been found:

PETROLEUM OF SLOBODA.

Density (zero) 0.937.

Carbon	82.44 per cent
Hydrogen	6.21 per cent
Oxygen	11.35 per cent

TARRY PETROLEUM.

Density (zero) 0.881.

Carbon	84.98 per cent
Hydrogen	12.35 per cent
Oxygen	2.75 per cent

Laboratory experiments corroborate this view. Engler and Bock, on submitting neutralized and boiling petroleum to the action of a current of air, obtained a special oxidation, a resinous product containing butyric acid. Favored by the presence of an alkali, these reactions produce carbonic acid and water.

Drilling.—The work of drilling has not been generally well understood in Algeria. If imperfect prospecting had not been the initial cause of the want of success which has arrested the development of the petroleum industry, the lack of adequate instruments for reaching petroleum at great depths would have also occasioned disappointment. This might have been attributed to the sterility of the location, when in reality the petroliferous richness was apparent at the surface.

To appreciate the judgment necessary in the choice of the boring mechanism, it is sufficient to consider the nature of the lands. They contain to a great extent layers exceedingly adherent to the tools (clays and marls) necessitating frequent pipage, diminution in dimensions, which before the level is reached where the presence of petroleum can be anticipated, are so reduced that it is impossible to continue the work. This is the general cause that has led to the abandonment of all the borings undertaken in Algeria above 450 meters.

There are three remedies: (1) The employment of strong machines for rapid boring, allowing undertaking a well of large initial diameter, contending by the velocity of perforation against the clogging of the pipes, and not reducing the diameter except at the last extremity; (2) the employment of boring with water circulation, contending against the clogging by continual cleansing of the opening; (3) the employment of enlarging shears, and an elaborate system of pipes screwed together in sections.

PRECIOUS STONES IN THE UNITED STATES, 1901.

THE following synopsis of the precious stone industry of the United States for 1901, and the accompanying table, showing the production of precious stones in that year, have been sent to the Division of Mining and Mineral Resources of the United States Geological Survey, by Mr. George F. Kunz, Special Agent in charge of precious stones.

The principal items of interest concerning precious stones during the year 1901, are as follows:

The yield of sapphires in Fergus County, Montana, was greater this year than in 1900, and two companies are now mining in the region where the blue stones are found. Exploration for the many fancy-colored sapphires has been carried on still further in the Rock Creek region, Granite County, Montana.

The deposit of rhodolite garnet in the Cowee Valley, Macon County, North Carolina, was worked extensively. Mining for dark blue, green, and yellow beryls, for amethysts, and for emerald matrix was carried on in North Carolina.

The formaline deposits at Mesa Grande, San Diego County, California, were actively worked, and a new nearby deposit was discovered. The localities described in previous reports of this Survey as producing the golden green chrysoprase have been purchased, or a control of them for a stated period has been acquired, and more or less mining for this mineral has been carried on.

Several new turquoise companies have been formed, so that seven companies are now actively engaged in mining that material, and are placing it on the market, accompanied by their respective trademarks as a guarantee that such stones as may change in color will be exchanged for others. New Mexico is the chief source of the turquoise supply.

The finding of one diamond in Lee County, Georgia, is of interest as coming from a new region.

Epidote crystals, magnificent as regards size and crystallization, have been found in Prince of Wales Island, Alaska.

Emeralds have increased greatly in public favor.

The diamond importation has been greater than in any previous year, and at no period have more fine and more very large stones been imported.

The presentation by Mr. Max Braverman of his collection of gems and minerals to the Golden Gate Museum, San Francisco, California, is worthy of note.

Within the last few years, more attention than ever has been paid to the quaint and fanciful cutting of all precious stones, the diamond included; and whereas, ten years ago, scarcely any other forms than the "brilliant" and the "rose" in diamonds were used, during the last year there has been a great demand for stones that are "pear-shaped," "marquise," "briolette;" also for table-cut stones in all forms—triangular, circular, hexagonal, and in the double rose form also; and a modification of the last form has been patented.

The following table gives the production of precious stones in the United States during 1901:

Diamond	$100
Sapphire	90,000
Ruby	500
Topaz	....
Beryl (aquamarine, etc.)	5,000
Emerald	1,000
Phenacite	....
Tourmaline	15,000
Peridot	500
Quartz, crystal	10,000
Smoky quartz	1,000
Rose quartz	150
Amethyst	500
Prase	....
Gold quartz	2,000
Rutilated quartz	50
Dumortierite in quartz	....
Tourmalinated quartz	1,000
Agate	1,000
Moss Agate	500
Chrysoprase	1,500
Silicified Wood (silicified and opalized)	7,000
Opal	....
Garnet (almandite)	100
Rhodolite	21,000
Garnet (pyrope)	1,000
Topazolite	....
Amazon Stone	200
Oligoclase	....
Moonstone	....
Turquoise	118,000
Utahlite (compact variscite)	250
Chlorastrolite	3,000
Mesolite (thomsonite, so called)	1,000
Prehnite	....
Diopside	....
Epidote	....
Pyrite	3,000
Malachite	100
Rutile	....
Anthracite	2,000
Catlinite (pipestone)	2,000
Fossil Coral	100
Arrow points	500
Total	$289,050

THE PEANUT CROP AND ITS USES.

By AMAZIAH WHITNEY.

THE American peanut is grown principally in Virginia, Georgia, Tennessee and North Carolina. These States produce annually about four millions of bushels, which retailed to the individual consumer aggregate a value of ten millions of dollars. Yet the peanut product is for the most part outside of any regular branch of manufacture, and has not yet formed the basis of any great industry. This is remarkable in view of the character of the plant, every part of which, except merely the tap-root, is capable of some economic use. While the plant itself has been known from the earliest times, as shown by its Sanscrit name Chinar Badam, it is only about fifty years since it attracted commercial notice. This was in the East Indian Presidency of Madras, where the growth of the peanut has increased until, during many years past, it has covered an annual aggregate which may be roughly estimated at two hundred thousand acres. As a plant of tropical or sub-tropical origin it has been commonly supposed to be capable of profitable culture only in warm countries. The opposite seems to be the fact. The peanut will grow and ripen wherever there are five months consecutively free from frost. Reliable authorities say that in the United States it will flourish from New Jersey southward along the Atlantic coast, as far north as Wisconsin in the valley of the Mississippi, and anywhere on the Pacific coast south of the Columbia River. From this it appears that the crop is planted in only a small corner of the regions where climatic conditions are favorable to its production on a considerable scale. While not at present an important element in American agriculture or manufacture, it is by no means impossible that it may become so.

Scientists describe the peanut as a "diffuse, herbaceous annual with procumbent branches," and in the botanical system of Linnaeus it is called *Araches hypogæ*. In popular phraseology in this country it is termed the peanut, perhaps because it is neither a pea nor a nut. It is, however, nearer the former than the latter, for it belongs to the leguminous order of plants, which includes peas, beans, clover, etc. The colored population of the Southern States refer to it as the "goober," while in other parts of the world it is known as earthnut and groundnut. By the Hindoos who cultivate it in large quantities it is called boni mug. A field of growing peanut plants very much resembles a field of clover, the growth shading the ground and choking the weeds. Like clover, it is believed to enrich the ground by assimilating nitrogen from the air and depositing it in the refuse left in the soil. This idea, however, is subject to some qualification. The peanut requires certain elements of fertility in the soil, without which it will not grow. Even very rich soils, if deficient in the requisite peculiarities, produce only vines and abortive shells, which latter are technically known as "pops."

The original habitat of the peanut is unknown. Some have claimed that it came from China through India. The better opinion seems to be that it originated in Brazil, passed to Africa, and then in a roundabout way to America. There are many varieties of the plant, and the products of the same variety very often differ materially according to the conditions under which they are grown. The East Indian plant is more stiff and somewhat more upright than its American congener. The typical American peanut is the Virginian, which sends its shoots sprawling along the ground in every direction. There is, however, a special variety of the Virginian known as the "bunch," in which the habit of growth is distinctly different. The nuts themselves have even greater divergencies in appearance and also in composition. There are in India two widely separate varieties. One of these has a light colored kernel which contains very little oil, but is highly valued for eating; the other has a reddish color, and while its edible value is not great it is very rich in oil. The common peanut, as we all know, has usually two, and very seldom three, kernels in a shell. There is in Costa Rica a variety which has four and five kernels in a shell. The difference in the composition of the kernels is, qualitatively considered, very slight in the various kinds, but quantitatively the differences are great. Thus in one Tennessee crop the kernels were found to have had as low as 3.87 per cent of water, while one variety of Japanese has shown as high as 15.61 per cent. An Alabama product has given as much as 4.26 per cent of ash, while two varieties of the Japanese show, each, less than 2 per cent. Nitrogenous extracts are derived from Georgia peanuts to the extent of nearly 22 per cent, while those of Bombay afford only a trifle over 10 per cent. These figures, however, are misleading, as the strength of the extracts is manifestly not uniform, the absolute nitrogen in the Georgia kernels being only 4.88 per cent, while those of Bombay yielded 5.40 per cent. Similar differences exist in other parts of the plant. Peanut shucks, which are not the shells, but are the paper-like inner coverings of the kernels, have more ash in proportion to their weight than has peanut meal, about half the protein, and about the same amount of fiber. Of course, the meal referred to is that which is made from the cake which remains after the oil has been expressed from the crushed kernels. Considered in detail the chemistry of the peanut is complex, but presents little of interest from a practical viewpoint. Those curious concerning the subject should refer to an elaborate article by M. Mertens entitled "Recherches de l'Huile d'Arachide" in the Moniteur Scientifique of the year 1899. Analysis of the vines and shells of all varieties show heavy proportions of lime which explains why this mineral is so essential to soils devoted to the cultivation of the plant. In this connection it may be remarked that while it grows best on a calcareous sand, containing more or less decayed vegetation, it takes kindly to many soils in which natural deficiencies are made up by artificial additions of lime, potash, humus and phosphatic material. A clean soil which will not adhere to the nuts is also a requisite to the successful commercial exploitation of the product. Mechanically considered the one essential of the soil is a fine tilth four or five inches in depth, which is not to be wondered at when we consider the growth and structure of the plant. Under favorable circumstances on new

soils a yield of from fifty to one hundred bushels per acre has been obtained in the peanut-growing regions of the United States, but in the absence of a judicious rotation of crops, and perhaps by reason of somewhat neglectful tillage, an average of twenty bushels to the acre is as much as is ordinarily looked for. The methods of cultivation and harvesting are thus far primitive to a degree and *mutatis mutandis* very much the same as those of other farm crops. The nut-bearing vines are plowed out from the ground, stacked for two or three weeks to dry and ripen and the sound nuts are picked by women and children. This is the most expensive part of harvesting, and applies to the Virginian and similar varieties. In North Carolina a smaller variety is grown with which the kernels are separated from the haulm by a kind of threshing machine, but it is claimed by many that this method is not entirely satisfactory. Before reaching the consumer the nuts pass through the hands of middlemen, by whom they are winnowed, cleaned and polished, and separated into four grades; of these grades Nos. 1, 2 and 3 go to the street stands, and No. 4 to the "burnt almond" and peanut candy manufacturers. Aside from these uses a portion of the crop has been, from time to time, devoted to the manufacture of oil which finds a market as a substitute for olive oil, and as such comes in competition with the high grade of cottonseed oil. The production of peanut oil is not likely to meet with any great degree of financial success in this country until the supply of peanuts is very greatly increased. A mill having a business sufficient to compete with other oil products would require perhaps fifteen thousand tons of peanuts annually, and at this rate two mills would work up almost the entire yield of the United States. The oil cake has high feeding value for animals, and rivals English bean meal and American cottonseed meal for this purpose. The vines or haulm make a good hay, which, however, requires care in feeding, and the shells when ground with other feed materials have a high nutritive value for stock.

From what has been said it will naturally be inferred that the peanut crop and its uses constitute literally an infant industry. This is further exemplified by the very slight extent to which it has attracted the attention of inventors. The first patent relating to the industry in this country was issued to one S. Shepard in 1857 for a stemming and polishing apparatus. The next, in 1868, to J. C. Underwood for a picking machine. During forty-three years only sixty-four patents have been issued, and of these twenty-four have related to cleaners and nineteen to roasters. The latter, of course, have for the most part been comparatively trivial devices which run into coffee roasters on one hand and corn poppers on the other. Deducting these the peanut industry has produced only about one patent per year, and this, aside from cleaners, means only about twenty inventions, good, bad and indifferent, relating to other branches of the industry. These include diggers, pickers, shellers, stemmers, polishers, hullers, assorting apparatus, blanching processes, "warmers" for keeping hot the roasted edible, and also one "peanut vending machine" for insuring economical retail disposal to the public. This paucity of improvement seems to indicate a neglect of promising and increasing opportunities. It would appear as if the whole art, from planting the seed to finishing the product for market, needs overhauling to bring it abreast of the times.

CARBURETERS.

We propose to use the term "carbureter" in the present article in a wider sense than that which is generally given to it. Usually a carbureter is understood to be an apparatus by means of which atmospheric air is saturated more or less completely with the vapor of a volatile hydrocarbon which evaporates freely at the ordinary temperature of the air, the air thus carburized being converted into what is to all intents and purposes an inflammable gas. There are, however, a number of appliances in use on internal-combustion engines in which this process does not take place, at any rate outside the cylinder, and in which it probably is only completed during or toward the end of the compression stroke. There are also other appliances for enabling engines to be run with the heavier oils which are not volatile at ordinary atmospheric temperature. We propose to include all these forms of apparatus under the general heading of "carbureters," and to consider their characteristics and peculiarities as compared and contrasted with one another.

Where we have to deal with volatile hydrocarbons, of which an example is the gasoline usually employed in motor cars, the problem differs a good deal from that which is presented to us where we have to drive an engine with the heavier kinds of oils. The ether saturator invented many years ago for use with limelight apparatus is in many ways the prototype of the gasoline engine carbureter. In this appliance ether, which is one of the most volatile combustible substances known, is poured on cotton wool arranged in one or more compartments in a box and oxygen under pressure is led through it. The oxygen takes up the ether vapor, and becomes to all intents and purposes a combustible gas, which may replace hydrogen for producing the oxy-hydrogen flame which is used for limelight purposes. What is a rather curious feature is that oxygen, fully saturated with ether, produces a higher temperature, and consequently a better light, than pure hydrogen.

The principles on which a large class of gasoline carbureters for explosion engines are constructed are mere application of the ether saturator, ether being replaced by gasoline and oxygen by atmospheric air. This applies to all those types in which carburized air is first fully saturated and then introduced with an additional charge of pure air into the working cylinder.

Carbureters may be divided into the following classes: (1) Wick carbureters; (2) Surface carbureters; (3) Spraying carbureters; (4) Vaporizing carbureters; and (5) Carbureters which involve a combination of two of these principles.

The wick carbureters are developments for motive power production of the ether saturator, that is to say, they use the principles on which that appliance is based. In general, a somewhat more durable substance than cotton wool has been employed; for instance, finely divided copper gauze or porous asbestos has been used, arranged in such a way as to be always kept moist by the gasoline, the air to be carburized being passed over a considerable surface of the porous material so moistened. Often this arrangement is reduplicated in a number of separate partitions.

Fig. 1 shows a simple form of wick carbureter, in which the air entering through the vertical pipe, *A*, bubbles up through the gasoline and is still further saturated by passing through a flame covered with lamp wicking, *B*, which draws up the gasoline and is thus kept moist. The air to make the mixture is admitted to the gas through the valve on top, as the gas passes out of the carbureter on its way to the motor. The gasoline is kept at the required level by a float feed arrangement not shown.

The Sales and Braby carbureter shown in Fig. 2 is a more complicated example of the wick carbureter, and has a mechanical feed. The suction of the motor raises the valve, *A*, and draws in air through slots, *aa*, arranged around the circumference of the tube,

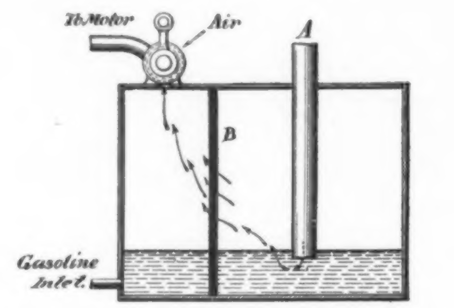


FIG. 1.—TYPICAL WICK CARBURETER.

B. Thence the air passes through slots, *d*, in the pipe, *D*, and is sucked upward through layers of fibrous material such as felt, *m*, interspersed with layers of wire gauze, *n*. The gasoline enters through the needle valve, *G* (which, by means of the rocker arm, *C*, and the stem, *b*, of valve, *A*, is opened every time *A* is raised) and falls upon the layers of wire gauze and felt, by which it is spread and absorbed. The air passing upward takes up the gasoline and forms gas. The air for the mixture is admitted through the valve, *M*. A pet cock, *P*, is placed at the bottom of the carbureter to drain any superfluous gasoline that might accidentally collect.

The earliest forms of surface carbureters were very simple appliances. They consisted, indeed, of little more than leading the air to be carburized through the gasoline tank, and relying upon the natural volatility of the gasoline to saturate the air. This arrangement is, of course, open to the objection that the volume of air in the receptacle increases as the gasoline decreases, with the result that the degree of carburization varies, and in consequence the driver of the engine has gradually to alter the feed of the mixture to the cylinder. A successful carbureter has been made on a development of this principle, in which the gasoline is kept by some special feed device at a

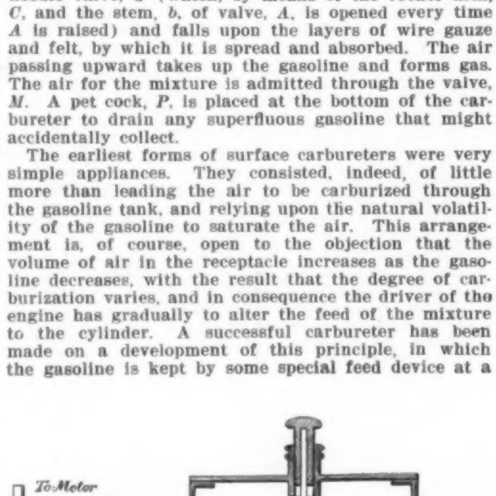


FIG. 2.—WICK CARBURETER WITH MECHANICAL FEED.

constant level in the carburizing chambers, and the carburizing chamber itself split up into a number of separate compartments. Sometimes the air was caused to bubble from one compartment into another, thus making the carbureter into a kind of Wolff's bottle, such as is familiar to every chemical student. Sometimes splashers were employed to effect an additional mixture of air and gasoline. But in all the principle was the same, viz., that of bringing the air into contact with as large a *surface* of the hydrocarbon as possible.

Phillips' carbureter, shown in Fig. 3, is a surface carbureter with spraying device in the form of paddles, *PP*, which are operated by the exhaust gases of the motor blowing on and turning a smaller windmill or paddle arrangement, *pp*, in a casing, *c*, in the upper chamber, *G*. The gasoline is warmed by the small pipe, *e*, from the exhaust, which passes along the bottom of the carbureter. Air enters through some small holes, *aa*, in the top of *C*, passes down through similar holes, *bb*, in the partition, and, after sweeping over the surface of the gasoline, makes its exit at the top through the valve (where air is mixed with the gas to form an explosive mixture), then passing downward and out at the right, through the pipe leading to the motor.

The spraying carbureter is really a development of the splashing principle. The chamber in which the carburization is effected has the gasoline atomized in it by the use of a very fine orifice, through which the liquid is forced or sucked at a high velocity. This spray vaporizes the gasoline in exactly the same way as in the splashing carbureter, and the air sucks it up and keeps it, as it were, in solution.

The Abeille carbureter, shown in Fig. 4, is a combination of a float feed with a more or less perfect pulverizing device. The gasoline is kept at the level of the top of the small feed nozzle, *G*, by the float feed

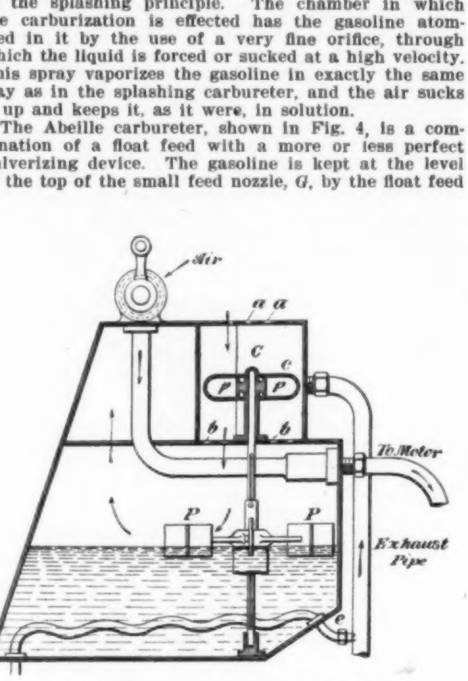


FIG. 3.—SURFACE CARBURETER WITH SPLASHING DEVICE.

arranged in a neighboring chamber. The suction of the motor drawing air up past the nozzle causes the oil to spout out of the top of the latter and spray upon the perforated cone, *C*, above, through the small holes of which air introduced at the top at *cc* passes and forms an explosive mixture with the gasoline vapor on its way to the motor. The holes, *cc*, may be regulated by turning a screw cap.

The Longuemare carbureter, Fig. 5, is constructed similarly to the Abeille, but its spraying nozzle is larger and is closed at the top by a conical cap, *A*, in the lower tapered face of which are four or five fine grooves, through which the gasoline is drawn up in a like manner of fine jets that spray upon several sheets of wire gauze, *B*, set in the pipe above. The air for the mixture is introduced through the curved pipe shown, the air to form the gas being drawn in at *O*.

In the vaporizing carbureters which were originally designed for the utilization of the heavier oils, such as kerosene, the use of a heated surface or chamber is adopted, on to or into which the oil is sprayed, generally in as fine a condition as possible, through

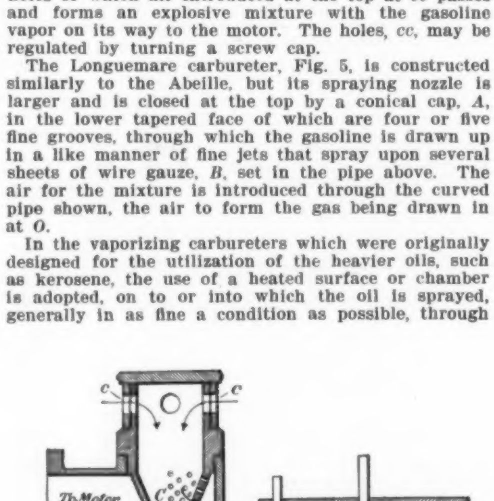


FIG. 4.—ABEILLE ATOMIZING CARBURETER WITH FLOAT FEED.

a jet. By the use of heat it was hoped to obtain the same effect with the heavier oils as was obtained with the spraying carbureters using the lighter hydrocarbon at a lower temperature. In practice, however, this was only found to be true to a limited extent. As instances of this class we have the Hornsby and Priestman, together with a number of others, among stationary engines. Only the Roots and the Koch engines employ it for automobile purposes.

Grove's carbureter, Fig. 6, illustrates this type, inasmuch as it sprays into a kind of mixing chamber, *A*, which forms a recess just off the main cylinder, *C*, and has a channel, *B*, arranged for the inlet of the oil in the seat of the inlet valve. The spraying takes place between the seat and the edges of the valve. A constant quantity of air is drawn in and the flow of gasoline is regulated to get the mixture.

Deutz's carbureter, Fig. 7, is another example of the same type, which is said to have given good results with kerosene. In this arrangement the valve, *e*, is opened by the positive action of a cam upon a cam shaft and allows the oil to issue from the space between its spindle and the surrounding walls. As it

issues from the seat of the valve it is caught by the inrushing air, which is divided into two portions, that entering through the main inlet valve, *d*, and that passing through the cylindrical chamber which surrounds the spindle of valve, *e*. The mixture is obtained by regulating the flow of gasoline by varying the amount of opening of the valve *e*.

A very large number of devices have been adopted for spraying the liquid hydrocarbon more or less directly into the cylinder. In general, with gasoline engines the spraying of the gasoline has been done into the feed-tube leading to the intake valve, the main body of the air required for a charge being taken in through a separate pipe. The well-known Daimler feed is of this type, the gasoline being kept at a constant level by a float feed, with the top of a tubular passage ending obliquely in the intake. The suction produced by the intake stroke causes the gasoline to be sprayed from the end of this orifice, where it is met and pulverized by the inrushing air,

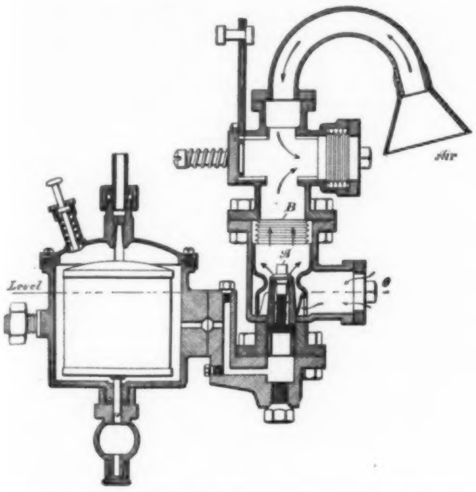


FIG. 5.—LONGUEMARE ATOMIZING FLOAT FEED CARBURETER.

by which it is more or less completely absorbed on its way to the cylinder.

A large number of inventors have employed themselves devising various spraying admission valves, by which the oil is pulverized and introduced directly into the cylinder. In most cases the air required for the charge passes through the same orifice. These appliances have generally been designed to enable the heavier oils to be used directly in the cylinder without the employment of a heated vaporizing chamber. They have been also adopted for use with the lighter hydrocarbons, but where it is desired to work with the lighter oils, as in the ordinary gasoline motors, the advantage of such an arrangement is not particularly obvious, and in some cases it has been found to give rather irregular results. As a means of employing the heavier oils for the production of power by spraying in this way direct into the working cylinder, these inventions have hitherto only had a limited amount of success.

New's carbureter, Fig. 8, is a spraying device with simultaneous cut-off in which the very valuable spraying effects of a cone working in a confined space are

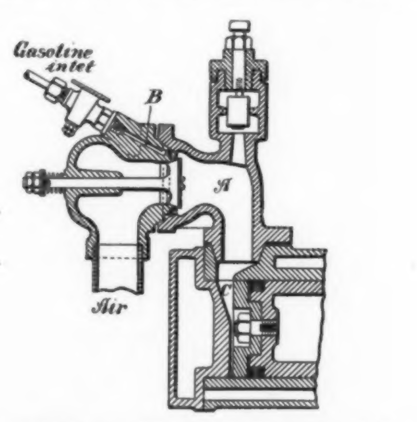


FIG. 6.—GROVE'S SPRAYING CARBURETER.

employed to effect the pulverization, while at the same time the tip of the cone acts as the cut-off of the oil feed. Gasoline enters at *P*, its feed being permanently adjusted by the vertical needle valve. The cone, *C*, which is mounted on the rod, *D*, and held up by the light vertical spring, *E*, is pulled down by the suction of the intake stroke, thereby allowing the gasoline to flow from the nozzle, *B*, and trickle down the sides of the cone, the main pulverization taking place around the base of the cone in the annular space which it leaves when open. The air enters through the apertures, *A*, and the mixture is obtained by allowing the right quantity of gasoline to pass.

Fig. 9 illustrates Capitaine's spraying admission valve. This device is of necessity kept in a practically vertical position. An annular channel, *a*, contracted toward the bottom, is arranged around the valve spindle just above the seat of the main inlet valve of the cylinder. When the inlet valve opens, the oil issues from the bottom of the annular space as shown in the diagram, and being met by the air on both sides, is pulverized to a certain extent, the atomization being further completed by choking the mixture of air and spray between the edges of the inlet valve and its seat.

In Merritt's engine, Fig. 10, the admission device is somewhat similar to Capitaine's, but the gasoline enters through the hollow stem of the valve and passes into an annular opening, *a*, in the conical valve itself, through holes in the face of which it is sprayed out by the inrushing air when the valve opens. The annular space, h^1, is kept filled with oil. The valve is positively actuated, and when it is opened by its rocker arm it is first pushed downward a little and a ring of small holes in its spindle (not shown in the diagram) enters the chamber, h^1, thus allowing a certain amount of gasoline to flow into the spindle and down into the hollow valve. A further downward movement of the valve carries with it the small plunger, h^2, which shuts off the supply of gasoline and keeps any more from entering the spindle. The engine was designed to run with kerosene, but is said to work equally well with gasoline. It is an interesting example of a spraying device, combined with a measuring appliance which measures out the oil for each intake stroke.

So far we have dealt in a cursory manner with the types of carbureter that have been invented. Most of these are familiar to our readers. It is when we come to consider which class of apparatus is based on principles which render it likely to supersede the

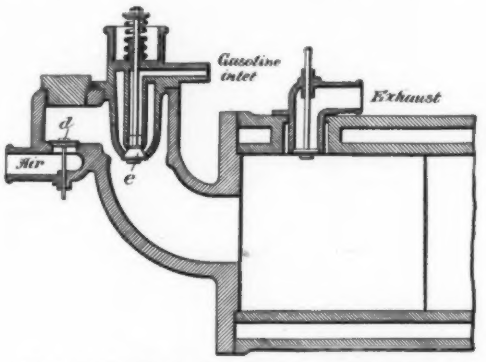


FIG. 7.—DEUTZ SPRAYING CARBURETER.

others, that we enter upon a very interesting question, but at the same time upon highly debatable ground.

With each class certain experimenters appear to have got good results, while with others the effects they obtained have been distinctly discouraging. There is little consensus of opinion on the subject, although the general tendency has been toward adopting the spraying form of apparatus. It may be of interest, therefore, to attempt to go to the root of the matter with a view to forming an opinion as to which class of carbureter is based on the most correct scientific principles, and which will, therefore, be most likely to survive in the struggle for existence, and be generally adopted in the future.

To do this we must consider what occurs in the cylinder of an internal combustion engine. An engine using charges of carburized air and ordinary air is a gas engine, pure and simple, and the carbureter is only a device for making the gas as it is wanted, it

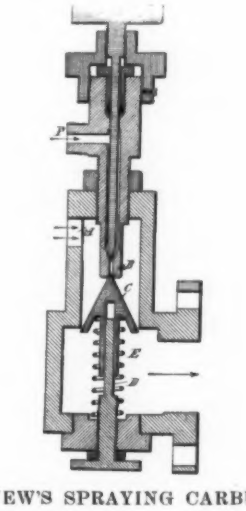


FIG. 8.—NEW'S SPRAYING CARBURETER.

being easier to carry gasoline in a tank than compressed gas in a heavy steel cylinder. But there is one respect in which such a gasoline engine differs from a gas engine, and it is a point which to some extent has been neglected. Fully carburized air differs from coal gas by containing a large amount of oxygen. As above pointed out, the oxygen saturated with ether produced by the ether saturator is a better fuel than pure hydrogen, probably because it contains part of the oxygen needed for combustion in very close contact with the molecules of the ether which is to be burned. Carburized air to a certain extent resembles ether-saturated oxygen, and is probably therefore better fuel than coal gas. This may be the explanation of the fact that more power can usually be got from a gasoline engine of a given size than from the same sized gas engine. It, therefore, does not altogether follow that we are going to get the same results in a given cylinder if we have the same amount of air and gasoline vapor present, irrespective of the condition under which it has got there. For instance if a certain amount of gasoline is necessary for the charge and a certain amount of air, a more effective explosion may be got if all the air has gone through the carbureter and been only partly but not fully carburized, than if the charge consists of two portions, one of fully carburized and completely saturated air, and the other of pure air, more especially if the latter enters through another channel. It has, in fact, often been observed that with surface carbureters the best output is obtained from the engine when nearly all the air goes through the carbureter. But to be able to do this the supply of gasoline to the carbureter must be controllable, and this certainly leads to the conclusion that the types of carbureter in which the gasoline is sprayed into the carbureting chamber, its feed being controlled according to the requirements of the engine, so as to cause a more or less complete carburization of the air, according to requirements, is likely to prove a better and more economical method of working, than to mix gulps of pure air and fully carbureted air at each intake in the cylinder, varying only their relative proportions.

When we come to consider the spraying devices which spray either directly into the cylinder, or into the intake so close to the cylinder that there is a practical certainty that a considerable quantity of the

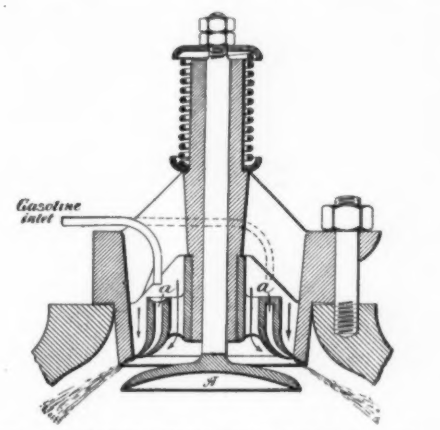


FIG. 9.—CAPITAINE'S SPRAYING INLET VALVE.

fuel finds its way into the cylinder in a liquid condition, we have a different state of affairs. During the compression stroke there is a tremendous rise of temperature due to adiabatic compression. Its amount is a function of the compression, the rate of cooling of the cylinder, the piston speed, and several other things. Its effect is to vaporize most of the oil which enters the cylinder in the liquid condition. But every liquid when converted into the gaseous state absorbs heat. The liquid oil consequently tends to a slight extent to cool the cylinder, but the heat that it takes from the cylinder is not, as in the case of that abstracted by the cooling water in the water jacket, lost to the thermo-dynamic cycle of the engine, but is contributed to it.

There seems to be some reason for supposing that in the types of gasoline motor which spray the fuel practically directly into the cylinder a greater output is obtainable from the same machine than where

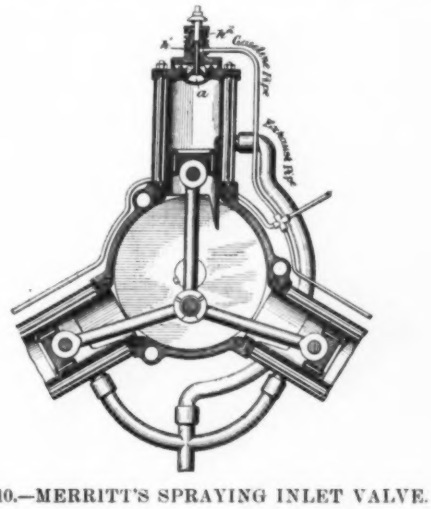


FIG. 10.—MERRITT'S SPRAYING INLET VALVE.

external carburization takes place in anything approaching the surface or wick type of carbureter. Spraying directly into the cylinder enables a larger charge of air to be drawn in than where the combustible portion of the charge is supplied as carbureted air. It means, therefore, that what amounts to larger and practically more powerful charges are being got into the same cylinder. This fact it is which may possibly serve, to explain the tendency to which we have alluded, and which undoubtedly prevails, toward the more general introduction of spraying types of carbureters, as well as the more regular working which characterizes their operation, and to which we have already referred.

Every oil engine attached to a motor vehicle is liable to more or less considerable variation of speed. The most usual systems of controlling the engine speed are the hit-and-miss method of governing, or the method of varying the speed by altering the firing point, which is the method usually adopted in cars with electric ignition. In these cases the ideal carbureter is one which supplies the same amount of fuel for each intake stroke of the engine, irrespective

of whether the engine is running fast or slow. In this case the power of the engine will vary directly with its speed, the power of the individual explosions being practically constant. Attempts to control oil engines by varying the amount of fuel admitted with each stroke, or varying its richness, have not on the whole been very successful. To make a carbureter fulfill the conditions above pointed out of ideal or comparatively speaking ideal efficacy, is not, however, as simple a matter as might, on first consideration, be imagined. Take, for example, any of the types of surface carbureter; the more slowly the air passes through them the more complete is the carburization. When, therefore, the engine is working at high speed there is a great tendency for it to be supplied with inadequately carbureted air. This is more especially the case where the arrangements are such that additional uncarbureted air is drawn in through a separate channel. For each charge, there is necessarily more back-pull, more skin friction, and more inertia generally about the air that has to pass through the carbureter than about the air that passes through the free passage. The amount of any fluid, whether gaseous or liquid, passing through a confined space under suction in a given time is proportional to the time integral of the period in question (in this case the period of a single intake stroke) divided by the surface integral of the skin or tangential friction of the fluid passing through the pipe. It would be easy to set this out in an equation in the usual style, but it is obvious, even without doing so, that the value of the above expression diminishes at a rapid pace the shorter the period of the intake stroke becomes. The balance is still further upset by the want of equilibrium as regards the friction opposed to the incoming air through the carbureter and through the air inlet. This means that where surface carbureters are employed a long pipe with considerable resistance must be inserted for the uncarburized air to enter through, while the carbureting surface should be made as big as possible, and with as little resistance as can be.

When we come to deal with the operation of spraying appliances at various engine speeds matters are, to a certain extent, worse even than with the surface carbureters. It is the suction of the piston that is in most cases relied upon to effect the spraying of the oil. The factors governing the amount of oil sprayed are precisely similar to those effecting the supply of carburized air as above described. But the differences in the amount sprayed during each intake stroke make a considerably greater difference than in the case of the surface carbureters, because the oil is vaporized after being measured out. It is for this reason that the employment of a pump or measuring device, which is not a mere device for opening and closing the oil feed, has been adopted in some types of carbureter that either spray into the cylinder more or less directly or into a small chamber situated close to it, so that there must practically be a squirt of oil corresponding to each intake stroke of the engine. The pump, if properly made, constitutes an accurate measuring device, and whether the engine runs fast or slow measures off the same amount of fuel for each intake stroke. This combination of a pump with a spraying device has, in the case of several different types of spraying carbureters, given rise to the most satisfactory results.

To sum up the results of our examination, the conclusion at which we are inclined to arrive is that the future development of the carbureter will be on the lines of a device for spraying more or less directly into the cylinder, combined with some form of measuring appliance or pump which will measure out the amount of fuel required for each charge, and pulverize it in such a way that it is carried into the cylinder at each intake stroke, that is to say, that there is no fuel sprayed and kept vaporized in the carbureter between the intake strokes, but that the oil is only sprayed and vaporized as it is required for each stroke.

This question of the use of pumps or equivalent measuring devices is not, however, quite as simple as it sounds to state it. To make a pump that will accurately inject the equal amounts of the heavier oils such as kerosene is feasible enough, but it becomes a much more complex problem to solve when we have to deal with the lighter oils, such as gasoline. It is exceedingly difficult to make plungers that gasoline will not find its way round, with the result that the pump is bound to vary its delivery according to the speed at which it works, while to attempt to compensate for this leakage by varying the throw of the pump with the speed is unsatisfactory and amounts to practical abandonment of the principle. There is, therefore, plenty of room left in this respect for the inventor, and it is upon the lines of the combination which we have suggested, that we expect to see the most satisfactory progress made in the future.—For the above article and the diagrams, we are indebted to The Automotor Journal.

CONSUMPTION TEST OF AUTOMOBILES.

A VERY successful concourse of automobiles has been held over the roads near Paris, the main point to be brought out being the consumption of liquid combustible per ton-kilometer. The route was laid out from Paris through Versailles to Corbeil-Essones, a distance of 50 kilometers (30 miles), which with the return made 100 kilometers. The weight of the automobiles with their occupants was taken at the controlling station before starting and the reservoirs of carbureting liquid were filled and officially sealed. On their return the amount of liquid consumed was carefully measured and this formed the basis of the comparison. There were a great number of starters in the six classes, motor-bicycles, moto-cycles, voiturettes, light and regular automobiles, heavy and industrial vehicles; and the total reached 74 machines. The results of the test are of interest, as they are among the first official figures which show the amount of combustible used by an automobile per ton-kilometer, and may be made the basis from which to estimate the cost of running. It is to be remarked that out of the 74 starters, nearly all made the entire run with the greatest regularity in spite of the wet and rather rough roads. There seems to be no question now that any of the standard automobiles can now leave for a 60-mile tour with the same assurance as for a simple trip across town. The accompanying table shows the figures for the consumption of gasoline and alcohol for the three main classes. The only alcohol used was the 50 per cent mixture with gasoline which is now prevalent; it is to be noted that the proportion of vehicles using alcohol is considerable.

No.	Type of Vehicle.	Carburant.	Consumption. Liters.	Total Weight of Vehicle.	Consumption per Ton-kilometer.
	Voiturette Class (200 to 40. kilos.)				
1	Peugeot	Gasoline	5.800	550	0.105
2	Richard	Gasoline	5.850	510	.114
3	Peugeot	Gasoline	5.870	550	.106
4	De Dion-Bouton	Gasoline	5.700	500	.118
5	De Dion-Bouton	Alcohol	7.540	535	.140
6	Clement	Gasoline	7.800	490	.159
	Light Automobiles (400 to 6.0 kilos.)				
1	Gladiator	Gasoline	6.190	700	0.0614
2	Darracq	Gasoline	6.570	750	.0876
3	Peugeot	Gasoline	9.420	1,030	.0888
4	De Dion	Gasoline	8.005	895	.0894
5	Gladiator	Gasoline	6.950	770	.0902
6	Korn	Gasoline	6.475	710	.0911
7	Ader	Gasoline	8.110	830	.0977
8	Darracq	Gasoline	7.415	750	.0988
9	Georges Richard	Alcohol	6.165	600	0.1027
10	Darracq	Alcohol	8.250	790	.1044
11	Gladiator	Gasoline	7.000	690	.1086
12	Darracq	Alcohol	6.840	620	.1103
13	Clement	Gasoline	7.900	710	.1112
14	Panhard & Levassor	Alcohol	11.800	1,055	.1118
15	Henriod	Alcohol	10.900	910	0.1197
	Standard Automobiles (650 to 1,000 kilos)				
1	Chenard-Walker	Gasoline	6.470	1,080	0.0599
2	Ader	Gasoline	8.510	1,350	.630
3	Henriod	Alcohol	9.850	1,210	.814
4	Bardon	Gasoline	8.360	975	.857
5	Bardon	Alcohol	8.950	955	.937
6	Bardon	Gasoline	8.300	880	.943
7	Mors	Alcohol	12.32	1,215	.1013
8	Gillet-Forest	Gasoline	9.345	1,044	.1044
9	Georges Richard	Gasoline	9.570	890	.1075
10	Mors	Alcohol	14.65	1,310	.1118
11	Mors	Alcohol	11.70	950	.1231
12	Delahaye	Alcohol	10.54	836	.1260
13	Delahaye	Alcohol	11.24	845	.1330
14	Sage	Alcohol	13.16	950	.1385

RAILROAD DEVELOPMENT IN ASIA.*

IT is always interesting, as well as important, to note the great advance that is taking place in railroad development in Asia. Although the work has practically been just begun, and much remains still to be achieved, it may be said, with truth, that Asia already possesses a system of railroads that may bear comparison with many of the great systems now operating in either Europe or America. With the completion of the Trans-Siberian line that continent will possess one of the most important lines in the world.

Taking the great territorial divisions separately we will be more easily able to arrive at a conclusion as to what has already been done and what it is proposed to accomplish within the near future.

INDIA.

The importance of railroads in India is largely increased, in a governmental sense, by reason of their forming strategical links between the various military cantonments through which the vast Indian population is held in check by a comparatively small army of British soldiers. This, more than any other incentive, has hastened the development of railways in India.

The main lines are two in number, and are known as the Bombay-Calcutta and the Bombay-Madras lines. The former crosses the great northern plain, the latter the great southern plain of India, and are both connected by means of branch lines with all the large cities of the empire—the capitals of the rajahs, maharajahs and nabobs. These two great trunk lines have also been extended to the farthest limits of India, and even into adjoining territories. For example, there is the line which crosses the Indus at Quittah and thence enters Afghanistan, the terminus of this line being not more than 60 miles from Kandahar. There is also the Burman line, which passes up the valley of the Irawaddy in the direction of the Chinese frontier. These three main lines, with their several offshoots, may be roughly sketched as follows: In the north, a direct line from Bombay on the west coast to Calcutta on the east coast; a line to Benares from Bombay; a direct line from Calcutta to Pechaver, on the Afghanistan border, by way of Benares, Delhi and Lahore; a line from Lahore to Kourratchi, with the branch line between these two cities to Kandahar. In the south, the main line between Bombay and Madras through Haiderabad; the line from Bombay to Goa, and from Goa to Madras, with lines connecting with Calicut and with the line from Madras to Tuticosia in the south. In Indo-China, the main line from Rangoun to the Chinese frontier, by way of Mandalay, and with an extension to Bhamo and another to Meaday. (It is proposed to extend the Bhamo line to Bishi and the main line to Yun-nan in China with offshoots to Tching-tou and Hai-pong.)

ASIATIC RUSSIA.

Next to the Indian system comes the Russian, which threatens to revolutionize the entire Far East. It is incontestably the most stupendous work that Russia has on its hands—the opening up of its eastern territory by means of railroad communication. Through this agency it hopes not only to explore and defend this territory, but to increase in value not less than one-third of the whole Asiatic continent. Already has most important work been accomplished. "From the Caspian Sea to the Pamirs, across the desert sands of Turkestan, the first trains have already been dispatched," the advance agents of modern enlightenment and engineering enterprise. There is a road to Herat and another to Merve, which is of great strategical importance to Russia. In the north, however, the most stupendous undertaking of modern times is rapidly nearing completion. This is the great Trans-Siberian line, which now stretches from St. Petersburg to Stretensk and the banks of the Amour; and, with a short gap which has yet to be completed, from Khabarovka to Vladivostok, the extreme eastern terminus of the line. As stated, the connecting link has yet to be made between Khabarovka and Stretensk, and two branch lines are also projected (in Chinese territory) between Stretensk and Girin, and between the last-mentioned place and Vladivostok. This portion of the work will be completed as soon as a settlement of the "Chinese question" has been definitely reached. It is even proposed to extend the line from Vladivostok, by way of Girin, Moukden and King-tcheou, to Pekin, and so into the heart of the Chinese empire.

ASIA-MINOR, CHINA AND INDO-CHINA.

In addition to the Indian and Russian systems, the latter of which may be considered completed, there are also important projects for the further development of Asia by rail. These may be grouped under three heads—Asia-Minor, China and Indo-China.

In Asia-Minor an extensive system of railroads has long been under consideration. The first survey for this proposed trunk line was made as far back as 1874, and was from Angora to Bagdad. The financial crisis of 1875 resulted, however, in the abandonment of the scheme, again considered in 1888, by foreigners interested in railroad enterprise in Asia. The Suitari-to-Angora line was conceded, in October of that year, to the Bank of Berlin, and on November 27, 1892, the first train was run. A branch line was shortly after built between Eski-Schehir and Konia and connected with the line to Smyrna. The success of this undertaking influenced the Sultan's desire to have the line extended to Bagdad across Mesopotamia, and the German syndicate was instructed accordingly. The survey was made in the winter of 1899-1900 by a commission under the presidency of the German Consul-General at Constantinople. Matters were hastened by the request of the Emperor William that the work be pushed forward as rapidly as possible, and this is now being done.

In China the lines actually in working order are as follows: Shang-Hai to Wo-Sung (built in 1898); Kai-Ping to Pe-Tang; from Tien-Tsin to within a short distance of the Great Wall, by way of Chan-Hai-Ouan, and with connection to Pekin (built by Li Hung Chang's advice and in length 298 miles). Of conceded lines, since 1897, the list is as follows: The Russian line through Tsitsikov, Kirin and Vladivostok, with a branch to Port Arthur and Nion-Chouang. (Begun in 1897, it is expected that this line will be completed in 1904. The length of the main line is 1,200 miles; that of the branch line 600 miles.) The German line from Kiao-Tcheou to Tsi-Nan, from Tsi-Nan to Yen-Tcheou, from Yen-Tcheou to Kiao-Tcheou (total length 621 miles). The Franco-Belgian line from Pekin to Han-Keou, the first line, it may be stated, to be constructed by imperial decree. In the north, this line has been completed, and is in working order, as far as Pao-Ting-fou, about 50 miles from Pekin; in the direction of the Yang-tse the work has been completed as far as Sin-Yang, 120 miles from Han-Keou. The line will connect with Tai-Yuan-fou and Si-Ngon-fou. The Anglo-German line from Tien-Tsin to Tchin-Kiang with connections to Tsi-Nan; the northern portion of this line is being built by German engineers, while the southern is intrusted to the English; the total length is about 620 miles. The English lines are being constructed by the Pekin Syndicate and the British-Chinese Corporation. The former of these is interested in the line from Tai-Yuan to Fou-Tcheou-fou (298 miles); the latter has obtained the concession for two lines from Shang-Hai, one in the direction of Sou-Tcheou, Tchin-Kiang and Nankin, the other to Hang-Tcheou and Ning-Po. In addition to these there are the following: In southern China, a line from Canton to Han-Keou, with a junction at Hong Kong, has been conceded to a Belgian syndicate, while there are proposed lines from Lavi-Kai to Yun-nan-fou, from Lang-Son to Long-Tcheou and from Nan-Ning-fou to Pekin, these lines being constructed by French syndicates.

In French Indo-China the most important project is the line which it is proposed to build in the Yun-nan-fou district. This is a French enterprise, for which the necessary loans are now being arranged in Paris. The total length of the line is 300 miles and will cost $20,000,000. Owing to a financial arrangement which has been made this cost will be borne by Indo-China and not by France itself. The colony will contribute a first amount of $2,500,000 and a guaranteed annual interest of $600,000, payable during the next 75 years. The balance of the capital will be furnished by the syndicate controlling the concession. This syndicate has also obtained the rights for exploiting the Haipong-Lao-Kai line, it being agreed that all profits are to be shared with the colony. The two lines, thus united and to extend from the Gulf of Tonkin to the capital of the Chinese province of Yunnan, will have a total length of 600 miles. According to agreement the necessary loan must be raised in Paris within three months; the Haipong-Lao-Kai line, constructed by the colony, must be handed over to the syndicate within the following space of time: The Haipong-to-Hanoi section before April 1, 1903, and the Hanoi-to-Lao-Kai section before April 1, 1905. No date has been fixed for the completion of the Lao-Kai-to-Yunnan-fou line, but it is required that the most important work (such as the excavation of tunnels, etc.) shall be in progress at the same time that the other sections are being built. Much hope has long been placed on the eventual extension of the short line from Phu-lang-Thuong to Lang-fou. Built in 1894 to 1899, it was mainly constructed for the purpose of carrying military stores for the French troops and for the extinction of piracy. Lang-Son being, however, only 60 miles from Long-Tcheou, a Chinese prefectorate on the Song-Ki-Song, an affluent of the Yon-Kiang, one of the important routes between Hong Kong and Yun-nan-Sen, it was decided to extend the line as far

*Compiled for the SCIENTIFIC AMERICAN SUPPLEMENT by C. T. Mason.

as Long-Tcheou and even to Pésé, a port on the Yunnan. During 1895-96 important negotiations were entered into between the "Fives-Lille syndicate" and the Chinese government; but, owing to a protest from England, which country controls the navigation of the Si-Kiang River, no further measures were taken, and the Lao-Kai line was adopted instead. The new line in the Yun-nan-Sen district will be of considerable value to France. The district is not only one of the most densely populated, but is also one of the most productive of all the Chinese provinces, producing coal, copper, tin and mercury in considerable quantities.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Sugar Industry in Bahia.—Like other States in Brazil where the raising of cane and the manufacture of sugar constitute a considerable industry, the State of Bahia, with its numerous factories, is experiencing its share of the loss suffered by the industry this year.

The depression commenced about two years ago, but as the profits were then sufficient, little was thought of the future, and when the final drop in price came this season, both the grower and manufacturer were as surprised as if it had not been foreshadowed.

The principal sugar-cane region in this State is within a radius of thirty miles from Bahia and is located chiefly upon the tide-water rivers which flow into Bahia Bay. The factories are usually considered as forming three groups, consisting of eighteen vacuum-pan plants, capable of producing Demerara, white and yellow crystals, and numerous small ones with trains of open kettles, capable of making only crude sugar, muscovado, wet or dry.

The sugar season in this district is from October to April, but is extended over a greater period if rain does not interfere with transportation. This year there is still enough cane in most sections to last at least a month longer, but, judging from the rainfall the present week, the rainy season has already set in and operations will soon have to be brought to a close.

Some of the large factories rely entirely upon the purchase of cane from near-by planters, though most of them plant for themselves. When cane is bought, it is upon a sliding basis varying with the price of sugar at Bahia, and in the following manner: When white sugar is worth 200 reis* (4.8 cents) per kilogramme (2.2 pounds), the price of cane is 5 milreis ($1.20) per ton, and for every 10 reis (0.24 cent), up or down, in the price of sugar there is a difference of 300 reis (7.2 cents) in the price of cane. This price was fixed after the month of November of the present season, but some factories pay a slight amount more or less.

In accordance with the rates adopted, the sliding scale is of benefit to the factories only when the price of sugar is 200 reis (4.8 cents) or more per kilogramme (2.2 pounds), for every increase of 10 reis (0.24 cent) in the value of a kilogramme of sugar would mean an increase of from 600 to 750 reis (14.4 to 15.6 cents) in the value of the sugar which a ton of cane would produce, while the additional cost of the cane would only be 300 reis (7.2 cents), or a profit of from 300 to 450 reis (7.2 to 10.8 cents). On the other hand, a diminution of 10 reis (0.24 cent) in the price of a kilogramme of sugar would mean a decrease of from 600 to 750 reis (14.4 to 15.6 cents) in the value of the sugar which a ton of cane would produce, or a loss of from 300 to 400 reis (7.2 to 9.6 cents).

It would seem that there might be a better arrangement as to cost of cane, whereby both parties might profit as a result of increase, and lose in like ratio in case prices should go the other way.

In Bahia, there has been little effort made to properly cultivate the cane. Modern agricultural implements are sadly wanting, the chief reliance being placed in hand culture with a hoe. A few large planters own plows and harrows, but it is with difficulty that they are able to get their laborers to work with them, and at one large plantation I was shown plows, the stocks of which have rotted away as they have lain in the fields unused.

It is true that one factory owner imported a traction engine and plow, but he has accomplished little. It is impracticable to try to plow up and down hills and in valleys where the very weight of a locomotive would prevent its operation. What is needed here most is a better class of field labor. On account of the natural conditions (which were fully explained in my report upon the sugar industry of Sergipe,† and apply here as well), the country possesses too many resources, and life is consequently too easy. For this reason, laborers follow their own inclination as to when, where, and how much they will work, and never do more than is absolutely necessary. Our sulky plows and cultivators, which can easily be drawn by a couple of mules or horses, and our harrows and other modern implements would do much to improve present conditions. There is great need for well-equipped schools, to give instruction in theoretical and practical agriculture.

In Sergipe, which is essentially a sugar-producing State, the farmer usually has his own sugar factory; here, he can sell his cane to a central factory and is not forced to grind, as is the case in Sergipe.

The factories of Bahia can be divided into two classes, the central ones, with vacuum pans and centrifuges, and the small, open-kettle system factories.

The former may be subdivided into factories in which interest on the capital invested is guaranteed by the federal government, factories which the State has aided by loans, and factories which depend upon private resources.

The first group is composed of two complete and two incomplete factories, the greater part of the stock of which is owned in England, while mortgages on the factories are in the hands of Dutch investors. These factories have never been very successful, which in one case is due to its location in a section where little cane is produced, and in the other to bad management. The first mentioned has not been working for two seasons and is in need of repairs which would almost amount to rebuilding, and the other is in almost as bad a condition, though it is working under lease this year. These two factories have not paid expenses for several years, yet I cannot find that they have made requisition upon the federal government for the amount guaranteed them. Both factories have exclusively Scotch machinery.

The incomplete factories represent only buildings, both of which are much better located than the factory first mentioned. If completed, they would doubtless pay, as they could be supplied by a rich cane section.

The second group is composed of three factories, all located in the Santo Amaro district. They have been built within the last two years, and I understand they are in good condition and have quite modern machinery.

I have visited one of these factories, which worked for the first time this year. It is situated in a rich cane section on the Santo Amaro Railroad—a State line—has good buildings and an abundant water supply. One of the mills and the engine for the same, the triple effect and vacuum pans and apparatus connected therewith, the filter presses, sedimenters, and tanks were purchased from an abandoned mill in the vicinity of Rio de Janeiro, and are not as modern as they should be for a factory mounted this year. The second mill and engine are new. They have also new continuous clarifiers, water-motor turbines, patent sugar mixers and pulverizers. Several of the pumps and the new clarifiers are of United States manufacture, and are giving satisfaction.

This factory has been in operation too short a time (about three months) to permit any prediction as to its probable success; but it would seem that its equipment was a little too expensive, and that some of our more modern methods might have been introduced to advantage in its installation.

One of this group of factories has exclusively German machinery, and, I understand, is doing very well.

The third group comprises thirteen factories, variously located. I have visited the greater number of them and find them in all conditions. In some instances, the owners have been improving their plant from year to year and have given the machinery proper attention, while in others the plants have run down and are on the verge of ruin.

Some of the factories of this group are being run by Scotchmen, who seem to be very successful sugar makers and engineers. Where they are given a free hand, with their Scotch tenacity and shrewdness, they are making a small profit for the owners, in spite of the ruinous prices of sugar, molasses, and rum.

In other instances, good factories are being run by laborers who are not sufficiently acquainted with the theory and practice of sugar making and are not strictly economical, and a loss is the result.

Most of the central factories have railroads for carrying cane, and I am pleased to note that some of the engines and many of the cars are of American manufacture.

It is impossible to give the number of small factories with open-kettle boilers, as no statistics have been compiled for this State; but they must number into the hundreds and include all kinds, from those with animal power to those with steam, as a motive force for the mill. Many of the steam-power mills have not been working this year, preferring to sell their cane to the central factories; but the smaller ones are far in the interior, and have had to work or lose all.

The reason our machinery is not more in use is because it is practically unknown, or because when an owner reads of our machines, he is unable to procure information as to price, etc. He writes abroad to the firms which have supplied him with his antiquated apparatus, and they furnish him with "just as good, or better;" but seldom with the original. This was recently the case with a continuous clarifier, which is failing to give good results.

The best method to introduce our machinery would be to send into this section a man who is conversant with modern machinery and methods and who can speak Portuguese or Spanish. If that cannot be arranged, it would be well to have some Bahia commission house assume the agency of our machinery, or at least catalogues and other data which might be consulted when occasion warrants. It is true that present conditions do not give hope for any great sales in the near future, but when the sugar industry revives, we should be in the field for the new machinery which will then be purchased.

I can supply the names and addresses of all of the central and of some of the smaller open-kettle factories. To the first class little could be sold, but to the second class much might be, though they are too scattered for me to give personal investigation. In any event, catalogues and circulars in English are undesirable, except for reference at this office. Catalogues should not be sent for distribution unless printed in one of the Latin languages—preferably Portuguese or Spanish.

From figures given me at several of the central factories, I have compiled the following table, showing the cost of the production of Demerara sugar testing 96 per cent:

Description.	Cost. Milreis.	
Cost of cane per ton.......	4.500	$1.08
Freight on same to factory.	.500	.12
Wood and other fuel......	1.350	.324
Sugar makers and laborers.	1.250	.30
Diverse	.100	.024
Freight to Bahia..........	.700	.168
Sack	.700	.168
Necessary repairs in factory	.700	.168
Commission in Bahia......	.230	.055
Total cost 75 kil. (165 lbs.) sugar	10.330	$2.407

A ton of cane will produce 75 kilogrammes (165 pounds) of Demerara—a high average—and this sugar selling at 158 reis (3.79 cents) would bring 11.850 milreis ($2.84). The molasses from a ton of cane is worth 1.300 milreis (31.2 cents), or a total of 13.150 milreis ($3.15) from the product of 1 ton, which cost 10.330 milreis ($2.40); profit, 2.720 milreis (75 cents) per ton.

In this calculation, the salary of manager, percentage of depreciation of factory, and interest on capital invested are not taken into account.

A ton of cane gives from 30 to 40 liters (31.7 to 52.8 quarts) of molasses, which sold in November for 32 milreis ($7.68) per pipe of 800 liters (845.3 quarts), but now has a price of 20 milreis ($4.80), with no buyers.

The land in the Bahia cane district is divided into three classes—massape, salao, and areia. The first is that variety of soil which is almost black in color, and when wet becomes a sticky mass. This is the most productive and sells at 70 milreis ($16.80) per tarefa (0.72 acre).

Salao is a poorer grade of land, chiefly found on the hillsides, and seems to be an adulteration of massape with sand or common clay; it sells for 50 milreis ($12) a tarefa.

Areia is the least productive grade cultivated, and, as the name suggests, is composed chiefly of sand.

The yield per tarefa this year in the Santo Amaro district has been from 20 to 30 tons, while in the Iguape region only from 16 to 25 tons have been produced, and in the other sections the output has been even less.

This year the cane has not been particularly good, the juice testing 7.5 deg. to 8 deg. Baumé during the first part of the season and now testing only 9 deg. and 10 deg. Baumé.

The following table shows the cost of planting in Bahia:

New Plantation. Description.	Cost. Milreis.	
Clearing land	80	$19.20
Burning brush	4	.960
Opening ground	10	2.40
Planting	10	2.40
Cane for planting, at 4.500 milreis ($1.08) per ton........	18	4.80
Cleaning four times, at 6 milreis ($1.44)	24	5.76
Cutting 30 tons, at 400 reis (9.6 cents) per ton.........	12	2.88
Transportation, 30 tons at 2 milreis (48 cents) per ton..	60	14.40
Net cost first year on 1 tarefa	218	$61.44

With a yield of 30 tons this would make each ton cost 7.200 milreis ($1.728); but similar cane can be purchased for 4.500 milreis ($1.08), therefore the farmer has lost 2.700 milreis (64.8 cents) per ton. He has in reality lost more, as the calculation is made upon the present cost of labor, and there has been a great reduction in prices this season.

Cost of Second Year and Thereafter. Description.	Cost. Milreis.	
Cleaning cane and care of same	60	$14.40
Cutting 25 tons, at 400 reis (9.6 cents) per ton.....	10	2.40
Transportation of 25 tons, at 2 milreis (48 cents) per ton	50	12.00
Total	120	$28.80

This would make the actual cost of a ton of cane in the second year and thereafter 4.800 milreis (97.9 cents), or a loss of 300 reis (7.2 cents), as similar cane can be purchased for 4.500 milreis (97.2 cents).

In these figures I have not taken into account the interest on money invested in lands and equipment, which would bring the loss to a higher figure.

The sugar industry in this State has been favored by a low export tax. In fact, no sugar except crude pays any tax, and crude sugar only pays 1 per cent upon value.—H. W. Furniss, Consul at Bahia.

Railway Construction in Guatemala.—The work of constructing the Northern Railway from El Rancho to Guatemala City is progressing most encouragingly. The grading has been completed to Sanarate, about fifty miles from Guatemala City, and from there the work will be rapidly pushed forward. I am informed that the road will be finished within the time specified in the contract, and that six months from now trains will be running between Puerto Barrios and Sanarate. From the latter place to Guatemala City a stage line will be established.

The completion of the Northern Railway will be of great benefit to Guatemala, as it will considerably shorten the time to New Orleans. Only about six days will then be required to reach the United States from this city, while the trip on the Pacific side takes from seven to twelve days longer. Freight transportation also will be cheaper than by the Pacific route. The railroad was not at all affected by the recent earthquakes, and work on it is progressing in a businesslike way.—James C. McNally, Consul-General at Guatemala City.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

* Taking the current market value of the milreis at 24 cents.

† See Advance Sheets No. 1352, May 27, 1902.

SELECTED FORMULÆ.

To Take Heat Stains from Polished Wood.—Fold a sheet of blotting paper a couple of times (making 4 thicknesses of the paper), cover the place with it, and put a hot smoothing iron thereon. Have ready at hand some bits of flannel, also folded and made quite hot. As soon as the iron has made the surface of the wood quite warm, remove the paper, etc., and go over the spot with a piece of paraffin, rubbing it hard enough to leave a coating of the substance. Now with one of the hot pieces of flannel rub the injured surface. Continue the rubbing, using freshly warmed cloths until the whiteness leaves the varnish or polish. The operation may have to be repeated.—Drug. Circ.

Polishing Soap for Silverware.—For the very finest silverware the following is recommended:

Good white or yellow soap, finely shaved	80 parts
Burnt magnesia	18 parts
Jewelers' rouge, finest levigated	2 parts
Water sufficient.	

Dissolve the soap in the smallest possible quantity of water, by the aid of heat; then incorporate the other ingredients.

The above is for keeping silverware, not badly stained, in the highest possible condition. For ordinary polishing purposes the following is recommended:

Good white or yellow soap, shaved fine	80 parts
Tripoli	8 parts
Alum (ammonia)	4 parts
Tartaric acid	4 parts
Lead carbonate	4 parts
Water sufficient.	

Proceed as before. Finally the following makes an excellent silver soap, its only drawback being that unless the maker is very careful in the preparation, or selection, of his levigated chalk, fine silverware is liable to be scratched:

Good white or yellow soap, shaved fine	100 parts
Levigated putty powder	4 parts
Ammonium carbonate	8 parts
Levigated chalk	16 parts

If you desire to color the soap, rose pink answers very well.

In regard to your remaining question, we are sorry to have to disappoint you, but, as we have tried to make our readers understand, we are as ignorant of the formulæ of proprietary articles, such as you desire, as yourself or any other person not in the confidence of the manufacturer, and there is no manner in which we can inform ourselves. The pretended "analyses" of such preparations, published in the pharmaceutical journals, are fakes and frauds, one and all. Why not originate something of the sort for yourself, and sell it on its merits?—National Druggist.

Golden Varnish for Copper.—

Shellac	170 parts
Dragon's blood	30 parts
Gamboge	5 parts
Saffron	2 parts
Alcohol, enough to form a thin varnish.	

—Drug. Circ.

Glass Drilling, Shaping and Filing.—Take any good piece of steel wire of the required diameter, file it to the shape of a drill, and then hold it in an alcohol or gas flame till it is at a dull red heat. When hot enough, quench outright in metallic mercury. A piece of good steel, thus treated, will bore through glass almost as easily as through soft brass. In use, lubricate with oil of turpentine in which camphor has been dissolved. When the point of the drill has touched the other side put the glass, if possible, in water, and proceed with the drilling very slowly. If not possible to do this, reverse the work—turn the glass over and drill, very carefully, from the opposite side. By proceeding with care you can easily drill three holes through glass three-sixteenths inch thick one quarter of an inch apart. In making the drill be careful not to make the point and the cutting edges too acute. The drill cuts more slowly, but more safely, when the point and cutting edges are at a low angle.

To bring a sheet of glass to any desired shape, put it into water and use an ordinary pair of shears. By careful trimming it may be brought very closely to the desired design, and the files will do the rest. In using the file keep the instrument wet with oil of turpentine, or with a solution of camphor in the same.—National Druggist.

Liquid Glue.—In a solution of borax in water soak a good quality of glue until it has thoroughly imbibed the liquid. Pour off the surplus solution and then put on the water bath and melt the glue. Let cool down until the glue begins to set, then add, drop by drop, with agitation, enough acetic acid to check the tendency to solidification. If after becoming quite cold there is still a tendency to solidification, add a few drops more of the acid. The liquid should be of the consistency of ordinary mucilage at all times.—Drug. Circ.

Petroleum Soap.—To make a petroleum soap containing 25 per cent of the oil, proceed as follows:

Beeswax, refined	4 parts
Alcohol	5 parts
Castile soap, finely grated	10 parts
Petroleum	5 parts

Put the petroleum into a suitable vessel along with the wax and alcohol and cautiously heat in the water bath, with an occasional agitation, until complete solution is effected. Add the soap and continue the heat until it is dissolved. When this occurs remove from the bath and stir until the soap begins to set, then pour into molds.—National Druggist.

Toilet Cream.—

Almond oil	400 parts
Lanolin	200 parts
White wax	60 parts
Spermaceti	60 parts
Rose water	300 parts

—Drug. Circ.

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